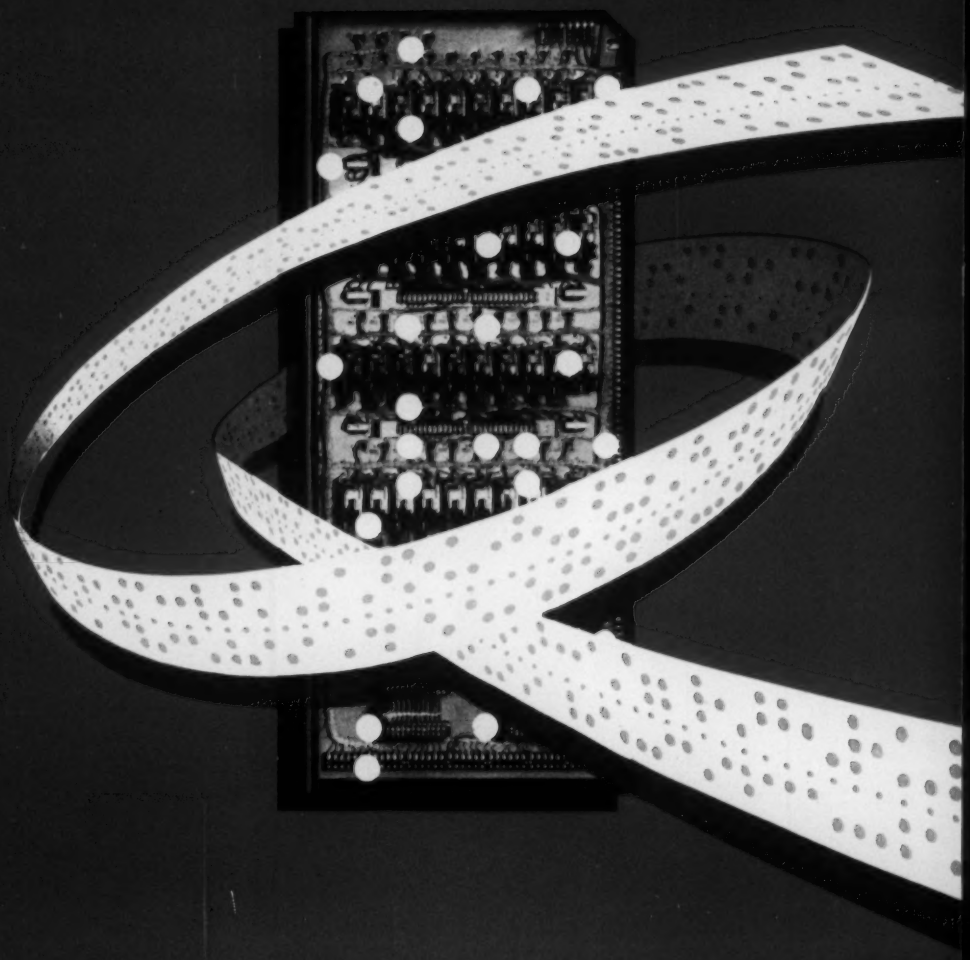
AUTOMATION

APRIL 1958



IMPROVE JOB-LOT PRODUCTION WITH

Numerical Positioning

The Magazine of Automatic Operations

- Integrated Machine Tool Systems
- Applying Magnetostrictive Actuation
- Orientation by Rotation
- Hydraulic Systems Engineering

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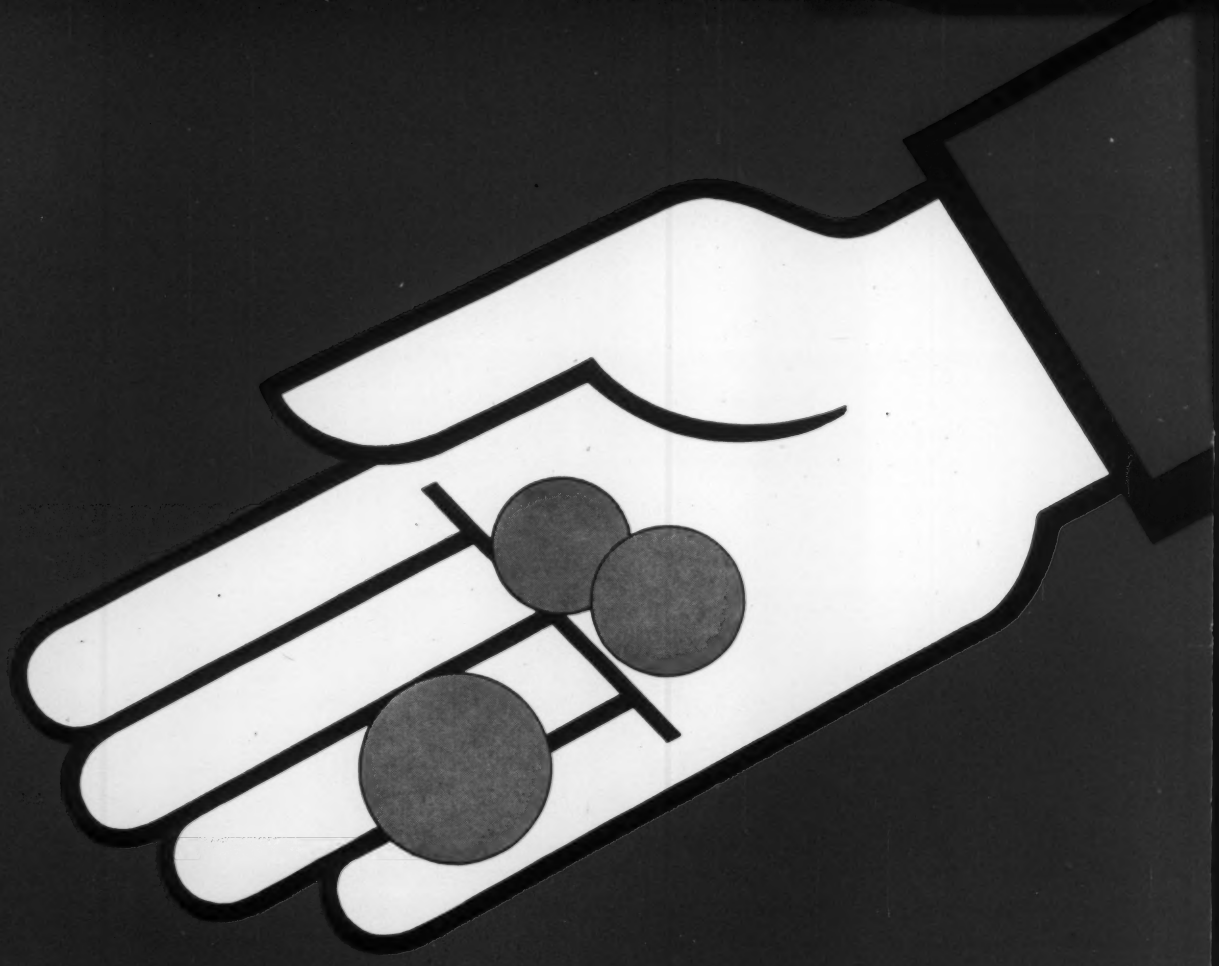

Still handing out pensions to obsolete machines?

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Talk to

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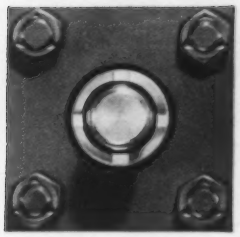
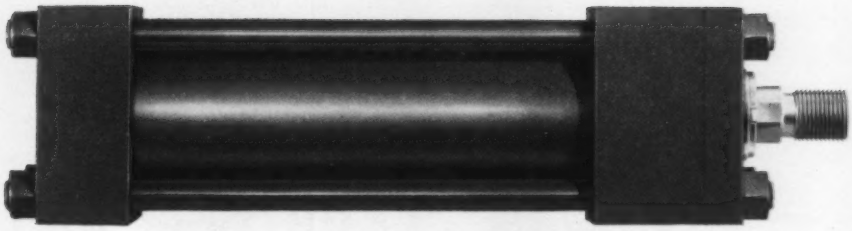
TOOL AND ENGINEERING COMPANY

3400 E. Lafayette, Detroit 7, Michigan

Special Machine Tools with Automation for More Than 30 Years



Made for the tough buyer



The discriminating engineer is intolerant—intolerant of anything but the very best in his plant and in his product.

For these tough buyers Hannifin cylinders are made. Into these cylinders go original, exclusive features of design, precision manufacture, and the ability to outperform others with the very minimum of maintenance.

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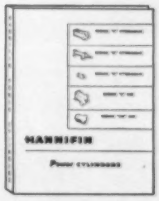

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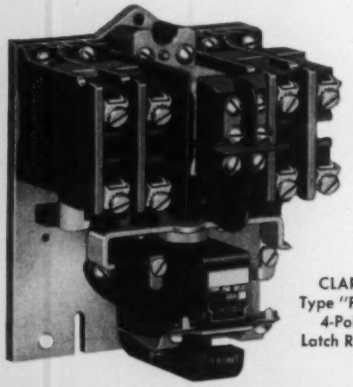
CLARK Type "PML" LATCH RELAYS

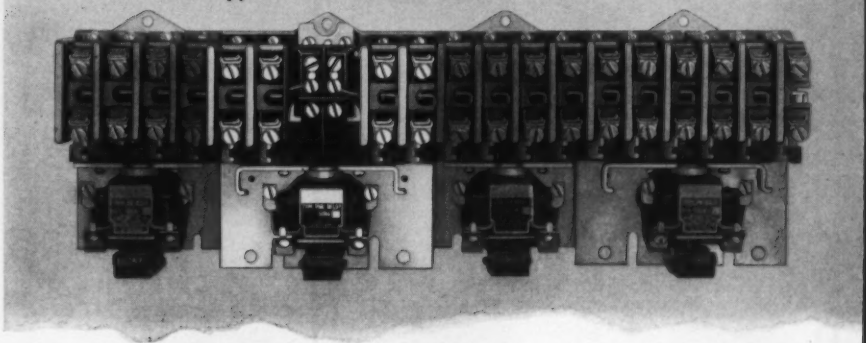
— have all features of CLARK Type "PM" Relays, including SECTIONAL POLE CONSTRUCTION

- **LATCH MECHANISM** replaces 2 poles of Type "PM" relay directly above relay magnet.
- **LATCH ASSEMBLY** easily removed or replaced as a unit by removing wiring and only two screws.
- **LATCH UNIT** has its own magnet—operates independent of relay magnet. No adjustment to get out of order.
- **LATCH COIL** is built for continuous duty—eliminates need for use of relay pole to cut out coil when unit is energized.
- **SPRING-LOADED LATCH** holds contact arm in energized position after relay magnet has been de-energized. Releases only when latch coil is energized.
- **LATCH WEARING SURFACES** are nylon against phenolic—minimizing friction and wear, and assuring longer life.
- **LATCH UNIT** is completely insulated from relay contacts.

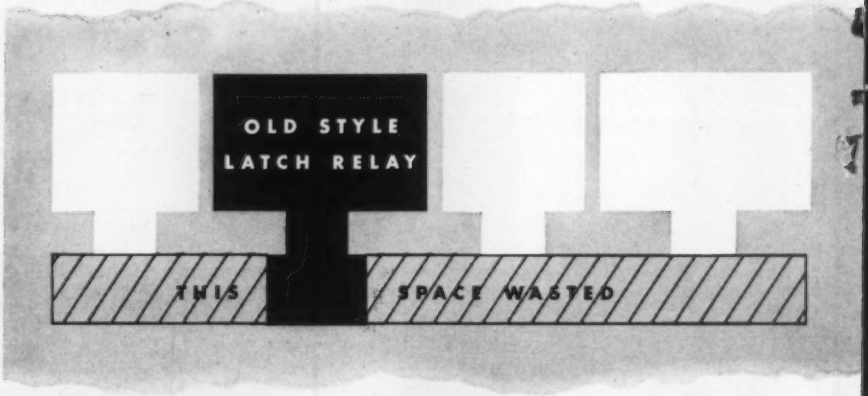


CLARK Type "PML" 4-Pole Latch Relay

CLARK Type "PML" LATCH RELAY



Clark latch relay in row with Clark Type "PM" relays. Note horizontal alignment.



Latching and non-latching relays of conventional design.

NEW!

CLARK Type "PML" LATCH RELAY

saves panel space by lining up with standard CLARK Type "PM" relays

Clark Type "PML" *mechanically held, latched-in* Relays have the same basic "modular" design as Type "PM", which have set new standards for flexibility of panel arrangement and economy of panel space. Contrasted with other latch relays, where the latch mechanism extends several inches below the magnet assembly, they have the same vertical dimensions as corresponding Type "PM" models—lining up perfectly with them, as shown above. The range of models shown below includes sizes and types to meet every demand for a 10-ampere latch relay.

For complete information, write for Bulletin 7305-PML

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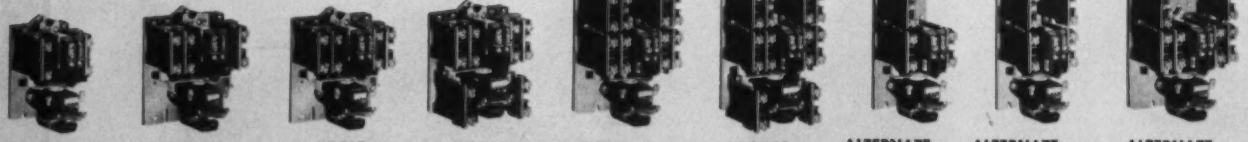

2 POLE | 3 POLE | 4 POLE | 6 POLE | 8 POLE | 10 POLE | ALTERNATE 3 POLE | ALTERNATE 4 POLE | ALTERNATE 6 POLE

APRIL 1958
Vol. 5—No. 4

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

PACKAGED AUTOMATION

". . . the manufacturers of metalworking equipment are in the midst of a minor revolution in their attitude toward their role as suppliers of both equipment and knowhow to industry. Since they have made great strides in developing individual manufacturing units which will perform almost every conceivable task automatically, they have now turned their talents for creating production hardware to the job of creating integrated packaged automation systems which will provide their customers with highly automated systems that have been engineered, tested, and debugged on the vendor's floor . . ."—*W. F. Jessup, supervisor, Automation Section, Engineering Service Dept., Cincinnati Milling Machine Co., see Page 50.*

DESIGNERS TO BE PRODUCTION-ORIENTED

". . . in the future . . . the design engineer will become more familiar with the complexities of mechanized production and process engineering, and will be better able to develop products that can be manufactured by advanced techniques. . ."—*Andrew A. Kucher, vice president, engineering and research, Ford Motor Co.*

PLANNING FOR PROFIT

". . . the prime consideration in planning ahead in bottling machinery must be that the various units make up a synchronized, automatic production line. Such a line must be so planned, designed and manufactured as to permit or allow the bottler the production of his packaged product ready for distribution at a cost per case that will allow for provision of sufficient funds for advertising, merchandising and sales promotion, and yield for his operation and efforts a satisfactory profit. Inherent, too, in the machinery for the years ahead must be the 'built-in' features of speed, sanitation, ease of maintenance, provision of flexibility for change in package size, and automation . . ."—*S. V. Tuttas, director of sales, Crown Cork & Seal Co. Inc.*

MACHINES MUST FIT MEN

". . . one of the paradoxes of automatic production lines is that they require less sweat but more brains. Industrial training experts are already exploring the problem of upgrading workers' skills and educating future workers to deal with more complicated capital equipment. However, only a few manufacturers of capital equipment are seriously considering how to make this increasingly elaborate equipment easier to operate. The study of the working relationship between a man and a machine is given the rather misleading name, 'human engineering.' Perhaps the most frequent 'human engineering' problem in an age of automation will be control organization. How do you take a mass of knobs, buttons, switches, dials, and designations and organize them so that a worker can operate his machine almost instinctively? Acres of automatic factory equipment mean acres of controls. And with all of this equipment functioning as a chain, a misread dial or the click of the wrong button can trigger off a costly chain of errors. Even with today's factory equipment, matching the machine to the man is a major problem; walk onto any factory floor and watch the workers fretting and squinting at their controls . . ."—*Henry Dreyfuss, industrial designer.*

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Penton Building, Cleveland 13, Ohio
Main 1-8260

R. C. JAENKE
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BPA NBP

"This used to take hours...

now the whole gearcase comes off in minutes!" Quite an accomplishment for an enclosed eccentric press. Too often the advantages of the enclosed design are gained by sacrificing the accessibility of the open design. Not so with Bliss, however: Bliss engineers count practical maintenance a design "must"—any new design that comes off the boards at Bliss keeps the maintenance man in mind.

Which is one more reason why industry agrees, "Bliss is more than a name ...it's a guarantee."

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100 years of making metal work for mankind

PRESSES • ROLLING MILLS • MILL ROLLS • DIE SETS • CAN MACHINERY • ORDNANCE

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PUT A BELLOWS AIR MOTOR ON YOUR COST CUTTING COMMITTEE

...and forget the hatchet!

Cost cutting programs that start out with a conference and end up with a hatchet may save a dollar today and cost ten tomorrow.

The cost cutting program that's worth its salt works on the assumption that the best way to save money is to produce in less time.

It's surprising how many of us miss the obvious. We're prone to look for the big saving and overlook the small. Yet the cost savings that can be made in literally scores of operations (each one perhaps, in itself, relatively minor but all part of the production picture) add up to big money.

Here's where we come in. The Bellows Air Motor and other Bellows "Controlled-Air-Power" Devices can shave costs faster than an electric razor can shave a peach. They do it by making automatic (or semi-automatic) almost any type of repetitive operation involving push, pull, lift or turn motions — with the direct result of less labor cost per part produced.

These ingenious electrically (or mechanically) controlled, air-powered work units can be easily installed on your existing machinery, or in combination with such standard items as brackets, switches, etc., can be made into low cost special purpose machines. When one run is over they can be easily dismantled and re-assembled to do another job.

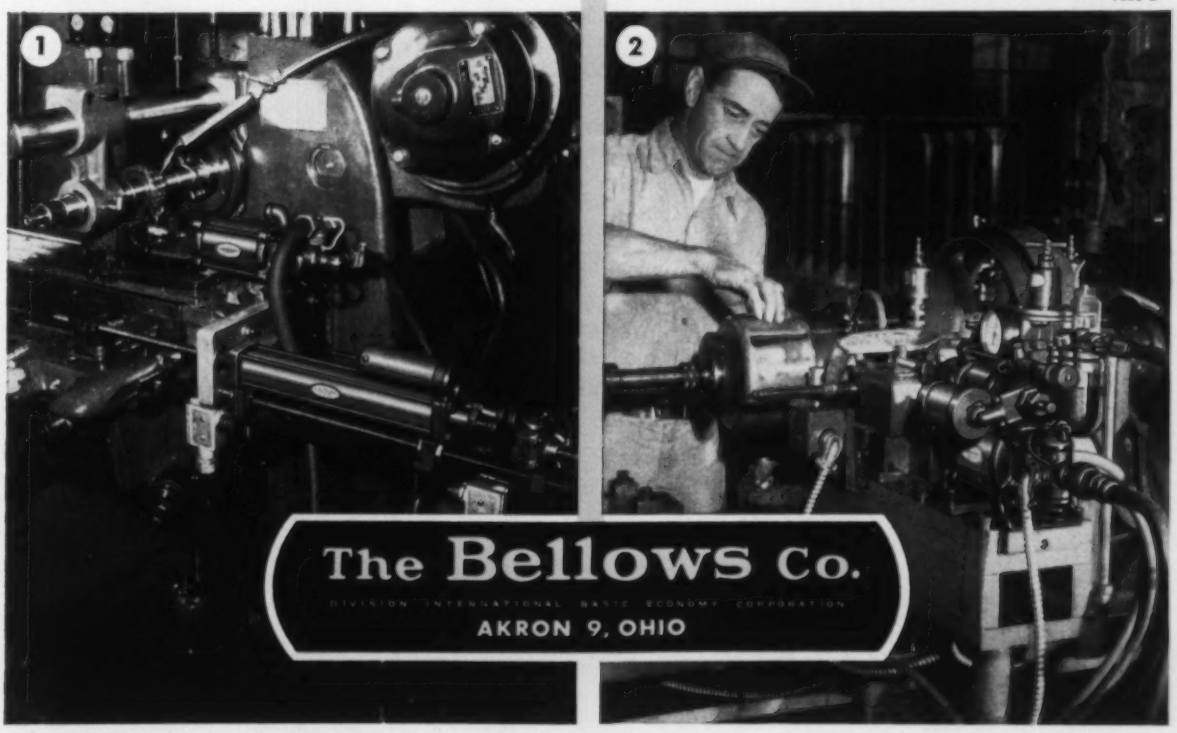
The two illustrations below are typical. Photo 1 shows how the Blackhawk Machine Co., Chicago, took a standard milling machine and with Bellows Air Motors made it into a high production unit. The increased output cut per piece costs 66%.

Photo 2 is a special purpose machine built in the plant of Amesbury Metal Products Co., Amesbury, Mass., with six Bellows units to control a spinning operation. It eliminated two separate operations. Production increase alone cut costs 50%.

For more information:

Write for Bulletins BM 25 and ML 3.
Address Dept. AU-458 The Bellows Co., Akron 9, Ohio. For quickest action pick up your phone and call the Bellows Field Engineer in your city.

1060-B



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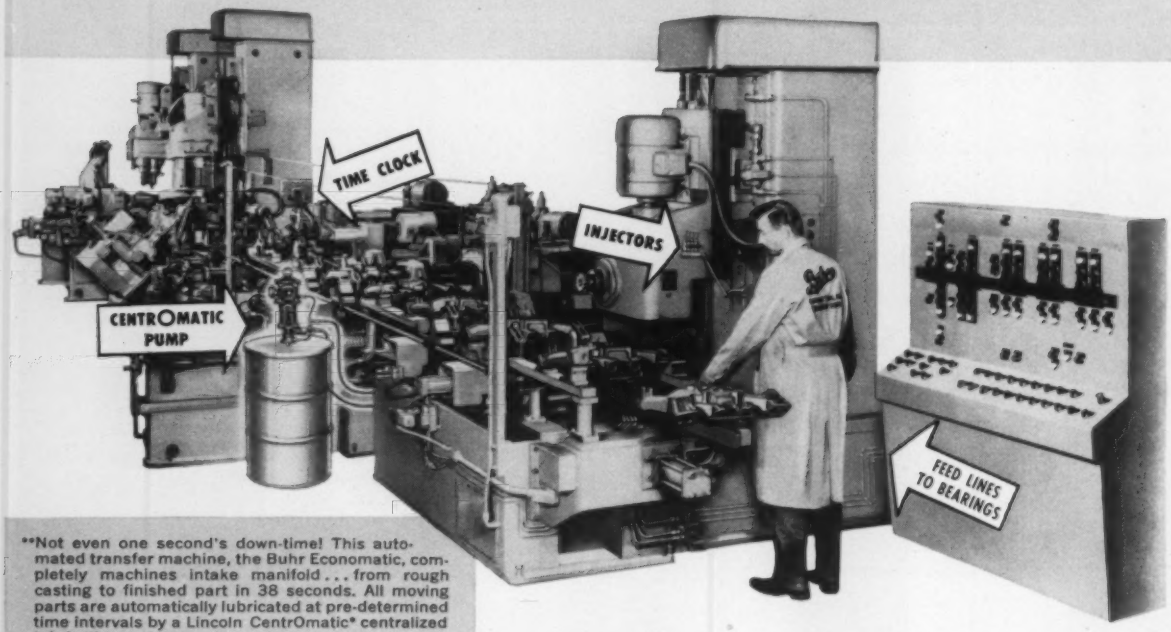
78 operations in 38 seconds... and no down-time for lubrication**



**Not even one second's down-time! This automated transfer machine, the Buhr Economatic, completely machines intake manifold . . . from rough casting to finished part in 38 seconds. All moving parts are automatically lubricated at pre-determined time intervals by a Lincoln CentrOmatic* centralized lubrication system.

Whether you need automatic maintenance for full automation, or simply grease fittings to keep bearings dirt-free . . .

Look to *Lincoln* for a complete line of lubrication systems that slash operating costs • step up production efficiency

Whatever lubricant application problem you may face, whether automated production lines . . . a low-cost automatic system for original equipment . . . or positive, dependable maintenance of existing facilities, Lincoln has the answer. Because Lincoln provides you with a complete line . . . from the new ball-in-top grease fittings to a complete selection of automatic centralized lubrication systems.

Remember, when you specify Lincoln, you select from the greatest range of lubricating equipment on the market, backed by more than 45 years of engineering experience. And, you have this big additional advantage: Sales and Service facilities are available through a coast-to-coast network of leading industrial distributors.

Contact your local Lincoln Distributor for experienced help in solving your plant operating and production problems.

Write for new Lincoln Catalogs, Nos. 80-1, 811-R.

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AUTOMATION news

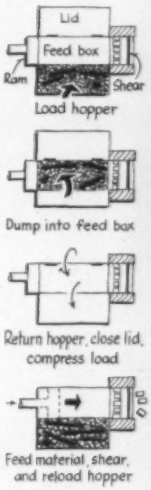
Today's events and developments in the field of automation

Scrap Handling Speeded By New Automatic Shear

FINAL TESTS are being performed on a new automatic scrap shear designed and built by Clearing Machine Corp. The new shear is expected to perform the same amount of work as the combined output of 5 or 6 alligator-type shears commonly used in the scrap industry. In addition to substantially reducing the manpower required to handle scrap, the machine will virtually eliminate the need for torch cutting in the yard.

Towering two and one-half stories high, the 600-ton shear is fully weather-proofed for outdoor operation. The unit will handle mild steel scrap in diameters up to 5⅜ inches or in plates up to 1½ inches thick. Scrap is sheared into given lengths which are adjustble in 6-inch increments from 6 to 48 inches. The machine output is rated at 30 tons of heterogeneous scrap per hour.

From the front, the scrap shear looks similar to a large Clearing hydraulic press. The similarity ceases at the rear of the press which contains automatic scrap loading and feeding equipment. A 22-foot long hydraulically-actuated hopper is used to load large pieces of scrap into a feed box leading to the shear blades. A lid closes on the feed box compressing the scrap, and a hydraulic ram pushes the material in predetermined steps through the shear blades.



AUTOMATIC scrap shear built by Clearing Machine Corp. cuts lengths of steel scrap into short pieces for shipment back to steel mills. Hopper at left rear of machine dumps 8-ton loads of scrap into feed box and a hydraulic ram pushes the material under the cutting blades. Alongside the photograph is shown a diagram of the sequence of operations performed automatically by the machine.

Operation of the scrap shear is relatively simple. While the machine is automatically processing a previous load through the closed feed box, a new charge of scrap is loaded into the hopper with a magnetic yard crane or other mechanical means. When full, the loading hopper holds 8 tons of scrap. At the conclusion of the previous machine cycle, the feed box ram retracts and the lid opens to receive the next charge. The operator pushes a *Start* button which actuates the hydraulically-operated hopper causing it to rise and dump the new load into the feed box. As the hopper automatically returns to its original position, a lid closes over the feed box and compresses slightly oversize loads with a downward pressure of 95 tons at the center of the cover.

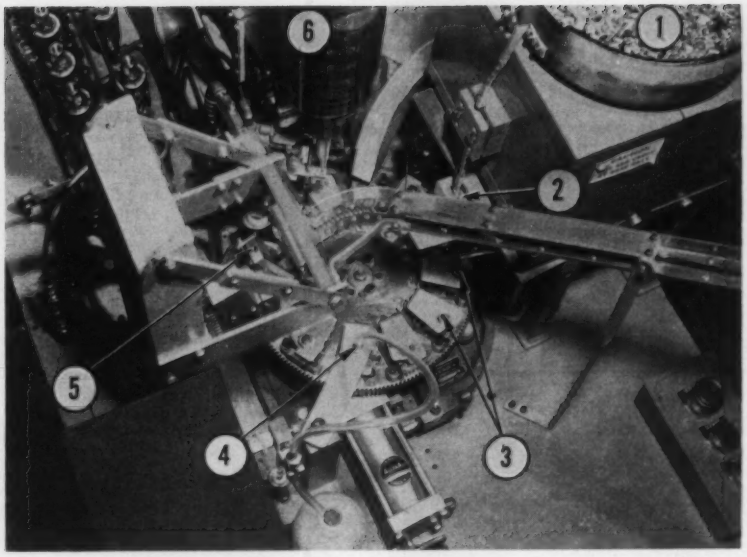
The hydraulic ram then moves forward a preset distance equal to the length of cut and pushes a load of scrap under the shear blades. At this point, hold-down clamps immediately to the rear of the cutting blades descend on top of the scrap and lock the material firmly in place to resist upward movement during shearing. The four-section, inverted "V" shear blade then descends and shears the scrap to the preset length. As the blade rises from the cut, the hold-down pressure is momentarily released to

LOCATED behind the shear blades are the loading hopper, feed box, and ram. While the ram feeds material through the shear blades for cutting to preset lengths, the loading hopper on the right is filled with another load of railroad scrap.

allow the ram to move the charge forward for the next cut. This cycle continues until the feed box is empty and the ram retracts to its starting position.

The hydraulic ram incorporates an automatic speed change mechanism to speed up the cyling of the machine. At the start of the push, the ram closes at a speed of 510 ipm until a pressure of 70 tons is built up. At this point, the speed automatically reduces to 255 ipm until a pressure of 180 tons is reached. From 180 tons to 600 tons, the ram operates at 85 ipm. When the feed box is empty, the ram automatically retracts at the initial speed of 510 ipm.

Based on cutting mild steel scrap into 18-inch lengths with a 4-inch intermediate ram pressure of 180 tons and a 2-inch full pressure of 600 tons, one complete cutting cycle will take 12 seconds. At this rate the automatic scrap shear will cut a full load in three minutes. After cutting, the scrap can be stock piled or loaded directly into railroad cars by conveyors or a magnetic yard crane.



TIME-CONSUMING assembly operations in semiconductor production are now performed automatically on a diode sealer machine developed by the Commercial Equipment Div., Raytheon Mfg. Co. The automatic machine produces 1500 finished diodes per hour which is equivalent to the work previously performed by 18 operators. The dial-type indexing machine assembles parts in the following steps: 1. Vibrator type hopper feeds diode can to escapement. 2. Escapement releases cans into hollow lower electrodes on dial feed. 3. Cans index to filling position. 4. Silicone oil meters into cans. 5. Diode stems feed on track across top of table and into fixture which inverts the stems and inserts them into cans. 6. Unit is hermetically sealed by welding in a standard welding head built into the machine.

Conference Studies Automation In Liquid Pipeline Industry

JOINT CONFERENCE was held in January between committees representing the Instrument Society of America and the American Petroleum Institute to discuss means of applying automation techniques in the liquid pipeline industry.

The Liquid Pipe Line Committee of ISA and the Automation Committee of API met to co-ordinate their respective 1958 project schedules in order to eliminate duplication of effort and to determine areas in which mutual assistance could be provided. Prime objective of the joint conference was to promote a standardization program and determine a method of distributing information concerning the economic application of automation in the industry. Objectives for 1958 include the preparation of statements of pipeline industry operational problems and the preparation of recommended procedures for instruction manuals, drawings, communication channels, instrumentation, and control equipment.

The API Automation Committee also outlined their 1958 program which included an industry survey on pipeline automation, reports on significant developments and industry trends in automation, and a bibliography on automation of pipelines.

Membership of the two committees is composed of engineers from Platte, Sinclair, Cities Service, Interstate, and Service Pipe Line companies. These engineers are responsible for the application of automation equipment to pipelines and are concerned with the standardization of techniques and proper distribution of knowledge related to these activities.

University Offers Diversified Automation Training Program

QUESTIONS are frequently asked as to what are institutions of higher learning doing about automation. The College of Engineering of Pennsylvania State University has answered this question by offering an active automation program designed to keep engineers abreast of the latest developments in the field.

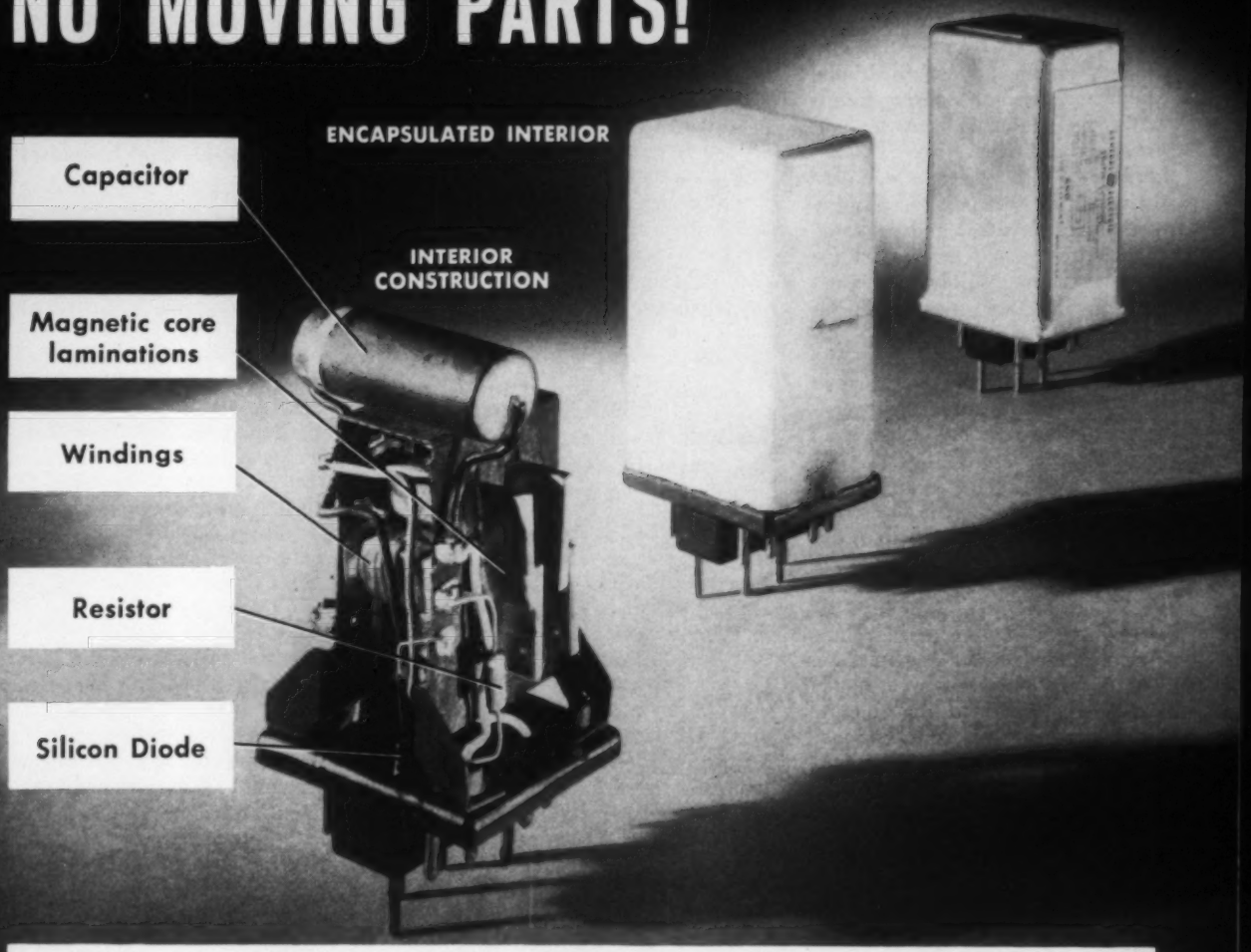
The University is attempting to cover the field ranging from undergraduate study to aid to small industry interested in automation. The program is currently offering an annual week-long automation seminar, an automation program to assist small Pennsylvania industry, an automation laboratory where industrial organizations can receive research and development assistance, and an undergraduate automation engineering course.

Topics covered in the automation seminar include material handling and transfer mechanisms, automatic feeders and escapements, hardware, and automatic equipment and design techniques. To provide more specific coverage of these and other problems, a series of half-day workshops is included in the seminar.

The undergraduate course in automation engineering is conducted on a lecture-lab basis. Lectures cover the fundamental principles of automation and their use throughout industry. Theory is supplemented by actual work in an automation laboratory which currently

Circle 658 on Page 163→

A control device with NO MOVING PARTS!



General Electric static control: easy to apply, virtually maintenance free

Here's a control device which functions as a relay—but without moving parts or contacts to service and replace. It's a General Electric static control element. Its life is practically limitless, because length of life is *independent of the number of operations performed.* Maintenance costs and possible shutdown because of relay failure are virtually eliminated.

The General Electric logic element is the heart of a static control panel. It performs the same function that a relay does in a conventional circuit—but more efficiently, more dependably. To apply just express the machine operations in logic functions and apply the proper static control logic elements.

A major automotive manufacturer has designed several panels using G-E static control components. The electrical supervisor of their manufacturing development section says: "G-E components make planning static control relatively simple, and they're practically fail-proof. One machine, where maintenance could be a real problem, was equipped with a static control panel about 12 months ago. To date, there hasn't been an electrical control failure of any kind. We've already converted three machines to static control, and have immediate plans to convert several more."

Want more information on what static control with General Electric components can do for you? Simply call your G-E Apparatus Sales Office, or write Section 733-43, Schenectady, N. Y., for Bulletin GEA-6578. *General Purpose Control Dept., Bloomington, Ill.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

houses several different types of transfer systems, automatic machinery, pneumatic and hydraulic equipment, machine tools being converted for automatic control, and a variety of feeders, controls, and hardware. Groups are formed consisting of three students representing mechanical, electrical, and industrial engineering. Each member of the group acts as consultant in his engineering field in solving problems related to the design of special devices for use in automation. The automation laboratory is also used by several small manufacturing concerns to solve a variety of industrial problems.

Building Block Standardization Interests Auto Manufacturers

CONFERENCES are being held between representatives of the automobile manufacturers and machine tool builders in an attempt to standardize on dimensions for building blocks that make up production machines. Representing the Ford Motor Co. are **L. G. Ringholz**, supervisor of Machinery and Equipment Utilization Section; **H. C. Daum**, manager, Machining Process Dept.; and **I. F. Bellmore**, senior buyer, Machinery Purchasing Dept. Completing the group are **V. A. Williams**, automation consultant for Chrysler Corp., and **R. R. Mitchell**, contact engineer of General Motors Corp.

The group is expected to complete its information gathering and have a set of standards ready for approval by the middle of the year. One of its primary targets is standardization on the machine tool work height dimension. Other problems being discussed during the meetings are the standardization of mounting and attaching patterns to provide interchangeability of basic components and units between different manufacturers.

Railroad Car Wheels Machined On Automatic Transfer Machine

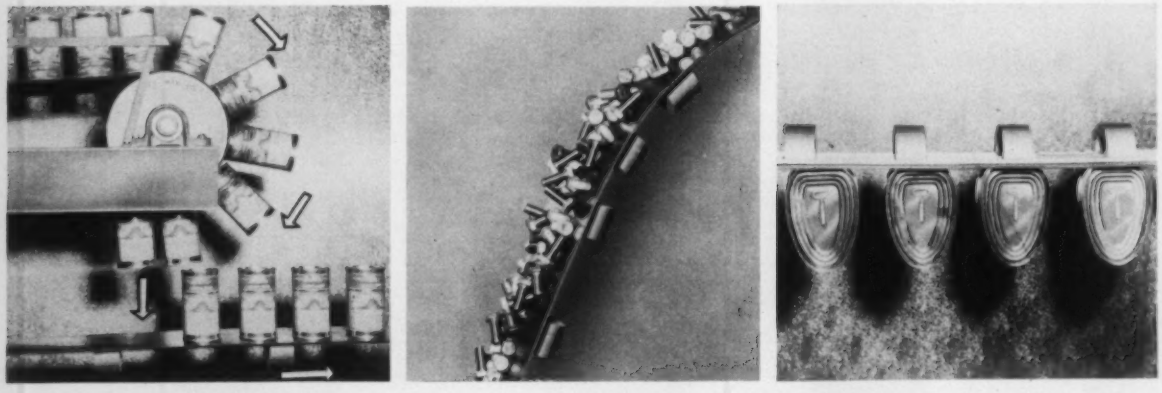
MANUFACTURE of railroad car wheels will be automated in a new transfer machine being built by Kearney & Trecker Corp. for Standard Steel Works. The 118-foot long machine will be delivered the latter part of this year and will produce finished wheels at a rate of one every 90 seconds.

In the past railroad car wheels have been machined on individual tools. In the new transfer machine, the wheels will be automatically transferred, in a vertical position, through eight stations at which the following operations will occur: Loading, rough boring, facing, turning, inspection, and unloading. The control system will allow the entire line to be operated as an interlocked unit or enable each machine and intermediate unit to be operated individually without affecting the rest of the line.

Commerce Department Forecasts Annual Instrument Sales Rate

SCIENTIFIC and industrial instrument industry will maintain an annual sales rate of approximately $3 billion during the first half of 1958 according to a forecast released by the Scientific, Motion Picture, and Photographic Div., Business and Defense Services Administration, Department of Commerce. In the second half of 1958, the annual rate is expected to rise sufficiently to bring the total year's sales to about $3.25 billion. This will be a small increase over the 1957 annual sales rate of approximately $3 billion.

Analysis of the trend within the instrument industry over the past eleven years formed the basis for the forecast. Sales figures for this period were correlated with expenditures for new plant and equipment; Department of Defense expenditures for aircraft, guided missiles, communications and electronic equipment; and government expenditures for increase of research and development facilities. These areas



BELT CONVEYORS are easily converted to versatile magnetic conveyor-elevators by means of a new system of bolt-together magnetic components manufactured by Eriez Mfg. Co. Available in various standard lengths, shapes, and magnetic strengths, the conversion units consist of 4 inch wide "rails" formed by joining face-plates of powerful permanent magnets. Installation is made by placing the units beneath new or existing conveyor belts. The magnetic field penetrates the entire working surface of the moving belt causing ferrous objects to adhere firmly to the belt while traveling at high speeds up and down steep inclines, around curves, or suspended from the under surface of the belt. Left picture illustrates a beer process line where cans are turned end-for-end around a magnetic pulley before dropping by gravity to a lower conveyor belt. In the center picture machine screws are carried up a steep incline—as much as 90 degrees—for entry into a packaging machine on another floor. The same system can be used for transporting small objects in the reverse direction. In the right picture food packages are suspended from the lower side of a belt conveyor and are speedily and safely carried to a labeling operation.

Circle 659 on Page 163→

THE IMPACT OF *Automation* ON TODAY'S BUSINESS

THE TOOLS OF AUTOMATION ARE BUILT BY AUTOMATION

As a builder of the tools of automation, Reliance Electric and Engineering Company has applied the best principles of this formula in designing an automated plant.

The new Ashtabula, Ohio Plant of Reliance which began full production early this year, represents an entirely new concept in efficient manufacturing of electric motors from 1 to 40 hp.

Techniques of automation were not considered feasible for relatively short run production, such as encountered in the manufacture of industrial electric motors.

Reliance engineers, working with many suppliers, designed and built a plant that is so flexible even single order lots can be run economically.

Automation afforded the most economical solution, providing fast production to meet customer specifications and maintaining the Reliance high standard of quality.

HORSEPOWER FOR AUTOMATION BY RELIANCE

This transfer machine, typical of machinery now in use at Reliance, is powered by 33 Reliance A-c motors. It is capable of machining 36 different motor frame castings at rates up to 70 units per hour.

A Reliance V*S Drive increased the production of this machine by providing a variable speed feed drive for the milling station, furnishing exact cutting rates and rapid tool traversing.

The transfer machine does the work of a milling machine, 11 vertical turret lathes, a multiple spindle drill and a five-spindle drill.

If you would like further information on Reliance Drives for any type of machinery, write for Bulletin A-1555-B, "Widening the Horizons of Automation".

A-1555

MOTORS AND DRIVES FOR INDUSTRY

A-C & D-C MOTORS | REEVES DRIVES | GEARMOTORS | V*S DRIVES

RELIANCE ELECTRIC AND ENGINEERING CO.

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CANADIAN DIVISION: WELLAND, ONTARIO
Sales Offices and Distributors in principal cities

of expenditures are significant to the instrument industry since they are closely related to instrument sales.

Expenditures for new plant and equipment are expected to be about $2.5 billion below the 1957 level. However, petroleum and public utilities industries, which are relatively large users of instruments, plan to increase their plant and equipment expenditures substantially in 1958. This factor tends to offset the negative spending by other industries.

Government spending for guided missiles, electronics, and communications equipment are expected to increase substantially in 1958. However, a time lag will be evidenced between the time contracts are let and the time instruments are placed on order.

Data Processing System Abstracts Technical Articles

INITIAL progress report has been made by International Business Machines Corp. on a method for producing abstracts of scientific and technical articles by using an electronic data processing system. The research project was initiated to develop means for faster and more efficient communications among the world's scientists.

In the machine abstracting technique under development, the selected article is first punched on IBM cards and then transcribed to magnetic tape for introduction into a data processing system. A computer in the system reads the magnetic tape and determines the significance of words by measuring the frequency of usage and the frequency of combinations and couplings. Using a set of instructions stored in the computer, the machine makes a table of values of word usage and placement and awards a significance factor to each sentence in the article. Depending upon the degree of these factors, the computer will select several of the highest ranking sentences and print them out.

The advantage of machine abstracts is that the original and only the original statements of the authors appear in the abstract and are not subject to misinterpretations by human evaluators. The selection of the key sentence or sentences is made through mathematical analysis, and a constant standard of abstraction is provided. By glancing at the key sentences provided by the system, an engineer or scientist can determine quickly the value of the complete document.

Annual ASTE Tool Show To Be Held In Philadelphia

ELI WHITNEY Memorial Lecture at the yearly meeting of the American Society of Tool Engineers will be delivered by **D. J. Davis**, vice president-manufacturing of the Ford Motor Co. The annual ASTE Tool Show and Meeting will be held in Philadelphia's Convention Center May 1-8.

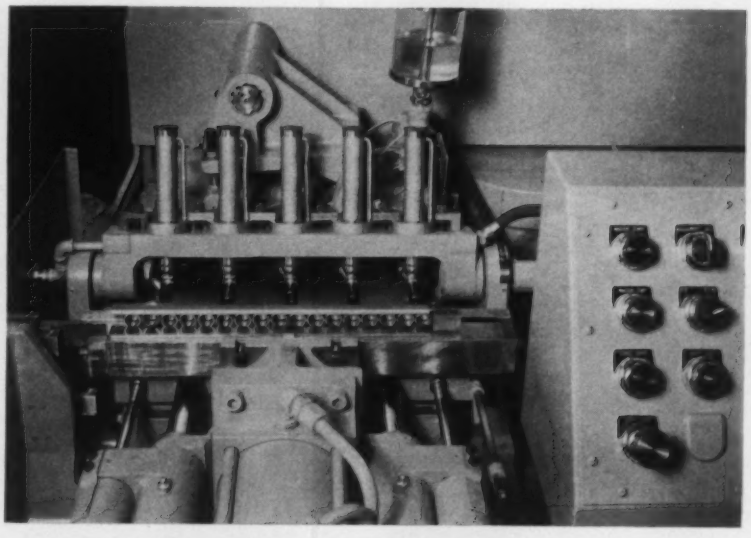
In making the announcement, **Harold E. Collins**, president of ASTE and foreign operations manager of Hughes Tool Co., stated the purpose of the lecture: "Each year the honor of delivering the Eli Whitney Memorial Lecture is awarded to an outstanding contributor to industrial progress whose achievements and professional service have emulated those of the teacher - poet-mechanic-lawyer-businessman whose name we hope to perpetuate in this series."

At the special luncheon being held in his honor, Davis will speak from his experience as a top-level engineering executive. In his lecture, entitled "Planning For Profit," he will discuss some of the more serious relationships between economics, manufacturing, and the science of management.

The theme for the 26th ASTE Annual Meeting will be "Tooling For Competition." One of the several papers discussing automation will be delivered by **J. C. Keebler**, managing editor of AUTOMATION.

Two Billionth Electron Tube Produced By RCA

TRAVELING-WAVE tube was the two billionth electron tube manufactured by Radio Corp. of America in twenty-eight years of tube-making. During this period RCA has produced enough entertainment-type receiving tubes and picture tubes to equip 17½ million television sets and 300 million radios. The remainder of the two billion



INNER and outer raceways for ball bearings are honed on a new line of multiple spindle machines developed and manufactured by Micromatic Hone Corp. The machines are designed with either 3 or 5 spindles, depending on the bearing size. The entire operation is automated and includes automatic loading and ejection, automatic cycling, and automatic feeding of abrasives. When abrasives require replacement, the machine stops automatically. Illustrated is a close-up view of a five spindle machine. The automatic loader and ejector is in front of the tool bridge and tapered arbors are directly below the bridge. Production on this machine finishing No. 8 inner bearings is 500 rings per hour. Output will vary from this figure depending on the size of the bearing and the condition of the rings as they come to the machine.

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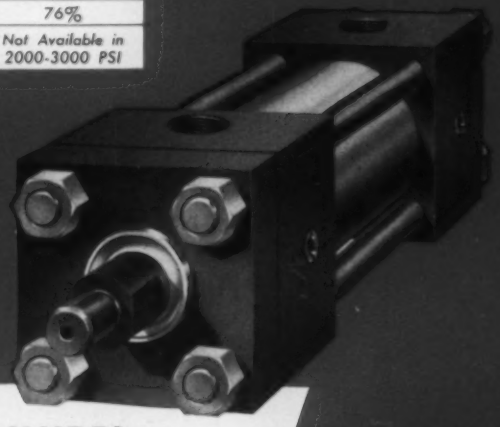

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COUNTERBALANCE CYLINDERS • BOOSTERS

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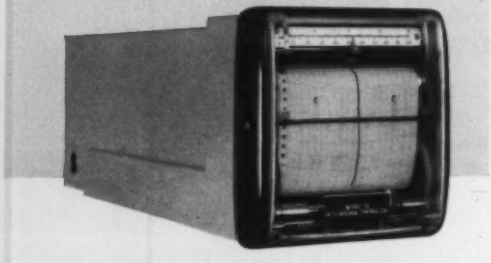
- **Low cost compared with other recording tachometers**
- **Operates on simple force-balance mechanical principle.**

Direct-connects to remote pneumatic recorder or controller, such as Consotrol panel recorder shown below.



At last — a tachometer with 3-15 psi air signal *directly proportional* to rpm! Speed changes are recorded on a uniform-scale chart. Accurate measurements of rpm are easy to read throughout the entire range. No crowded bottom scale!

The Type 16A Speed Transmitter is available for ranges from 0-320 rpm to 0-5300 rpm. Full-scale accuracy of ±½% is consistently maintained. Small and light weight, it can be mounted *in any position* — never needs lubrication.

For rotating equipment having wide speed variations, the Type 16A is ideal. It's available for either clockwise or counter-clockwise rotation, and can easily be incorporated into any present pneumatic control system. Write for full details. **The Foxboro Company, 124 Norfolk Street, Foxboro, Massachusetts, U.S.A.**

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PNEUMATIC SPEED TRANSMITTERS

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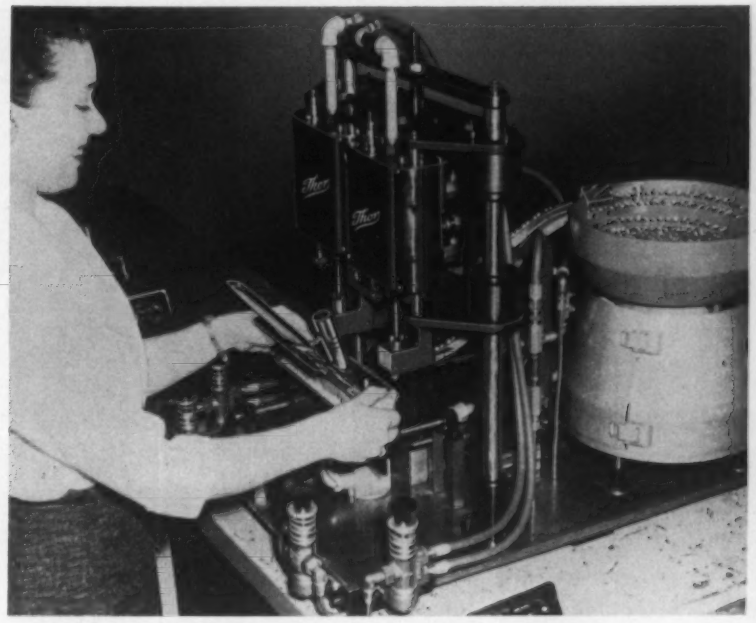

TWO-SPINDLE nutsetter is used by the O-Cedar Div., American-Marietta Co. to assemble 1200 sponge mops an hour. An electrically-driven vibratory unit feeds two wing nuts to two airdriven nutsetters. The operator places a mop frame on the sponge refill studs and activates the machine by pressing a foot valve. The nutsetters descend and tighten the wing nuts to a predetermined tightness, and then automatically raise to permit removal of the completed mop. The machine can be mounted on a bench or table and was developed by Thor Power Tool Co.

total produced consisted of industrial receiving and power tubes, and tubes for television cameras, oscilloscopes, and microwave equipment.

The record setting tube came off the assembly line at RCA's plant at Harrison, N. J., and the event was witnessed by the company's president, **John L. Burns.** "The Radio Corp. of America is proud to be the first electronics company in the world to manufacture two billion tubes," Mr. Burns said. "The electron tube is a basic component of all the equipment upon which our industry has grown. Through its ability to generate, detect, and strengthen electrical signals, the tube makes possible virtually every form of modern communications and home entertainment, as well as the complex electronic systems for business, industry, and defense."

Also at the ceremony with Burns was **D. Y. Smith,** vice president and general manager, Electron Tube Div. Smith explained that the RCA division buys goods and services from some 3000 suppliers, the majority of whom are comparatively small businesses. "In manufacturing the 17½ million television picture tubes made to date," Smith pointed out, "we required more than 150,000 tons of glass; . . . thousands of tons of stainless steel; 1500 miles of tungsten wire; and 14,000 miles of nickel and copper wire."

For nearly two decades, the bulk of RCA's tube production was in home entertainment types. With the increasing use of electronic equipment by commercial and industrial firms, RCA has expanded its line of tubes to provide more than 800 different types, ranging in price from less than 50 cents to over $20,000.

Educational Grant Promotes Foundry Graduate Study

HIGHLIGHT of the Foundry Educational Foundation College-Industry Conference held in Cleveland during March was the announcement of a $100,000 educational grant from Wheelabrator Foundation to the F.E.F. In announcing the grant, **James F. Connaughton,** president of Wheelabrator Corp., said that the major provision of the grant is to establish 50 fellowships of $1500 each to be distributed during the next ten years. The remaining $25,000 can be used by F.E.F. for scholarships or other edu-

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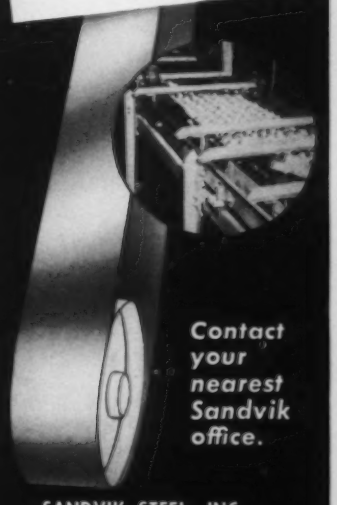

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SS-165

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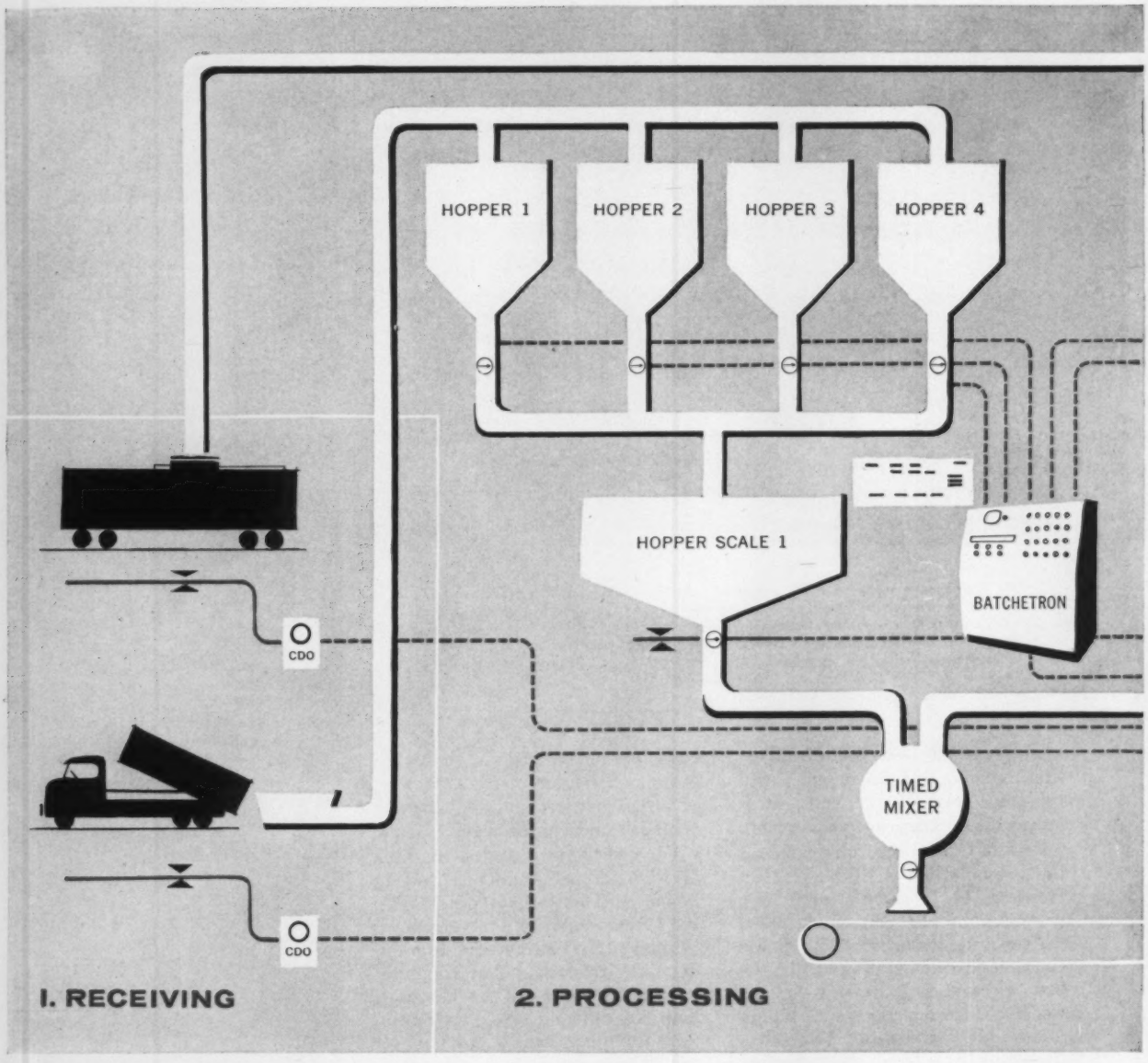

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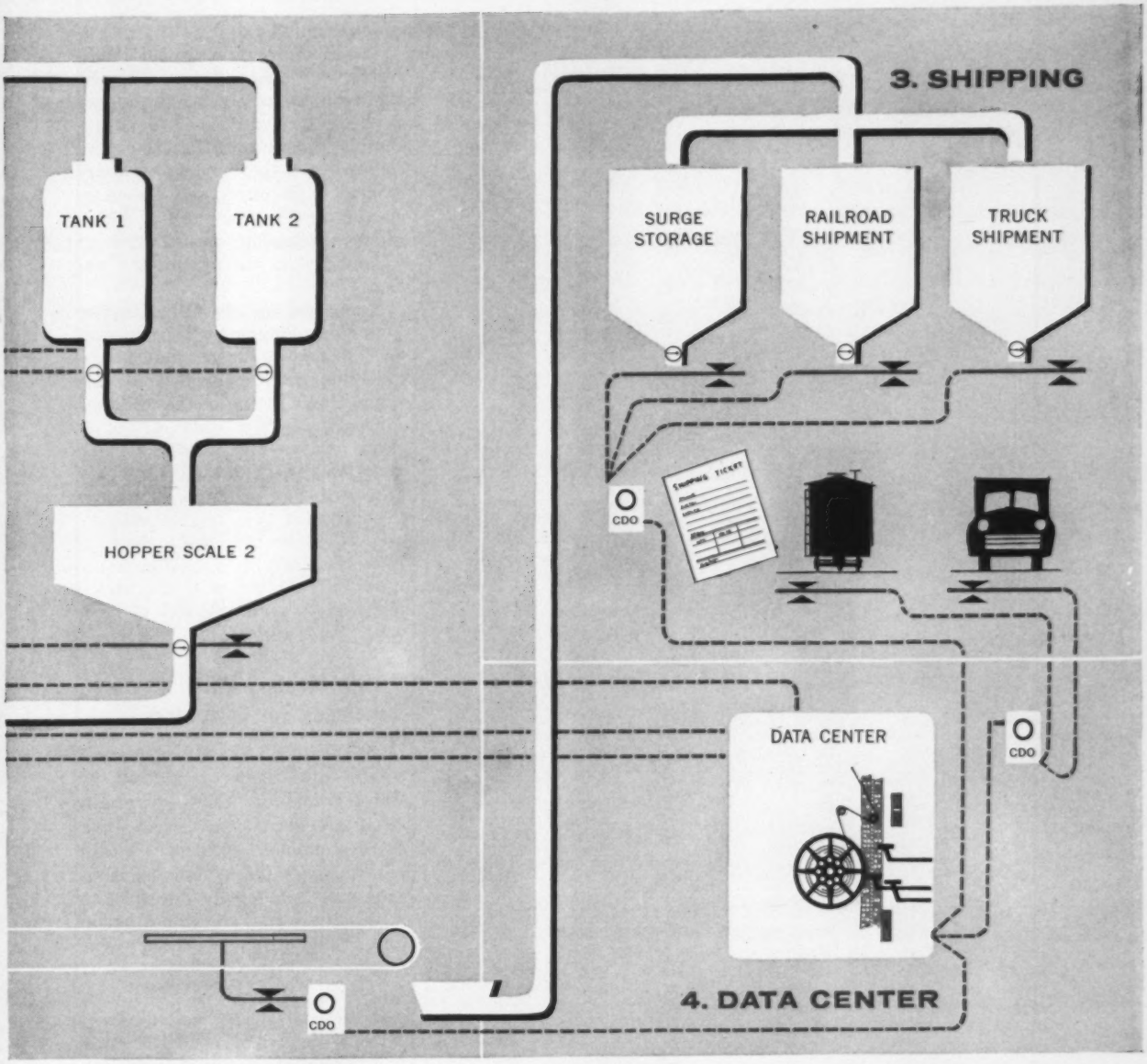

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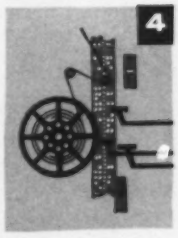

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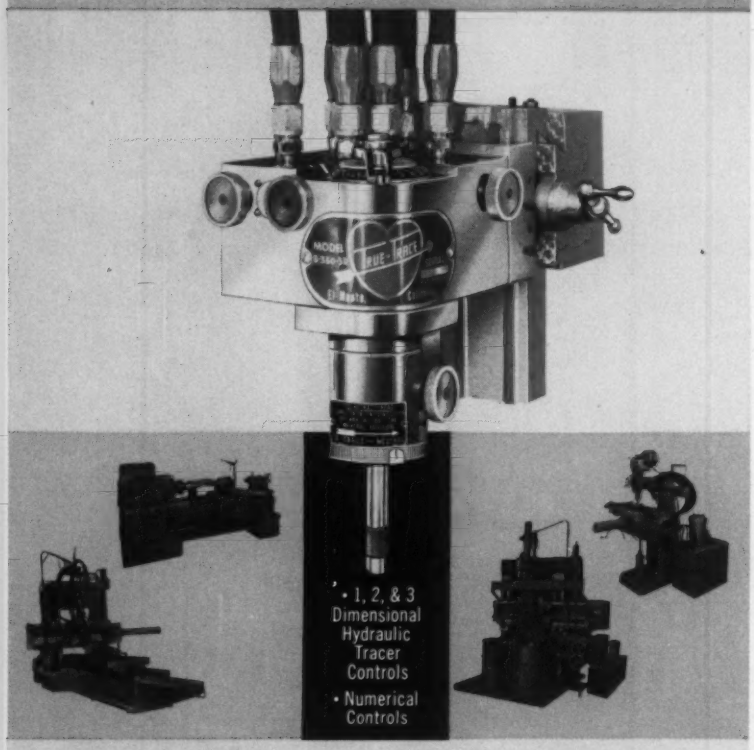

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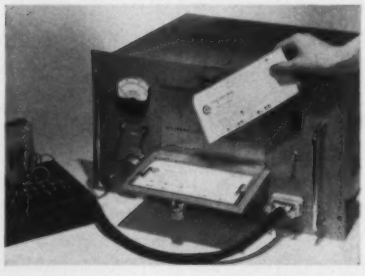
cational purposes.

The Foundry Educational Foundation was established in 1947 by six organizations serving the foundry field. It is dedicated to an extensive program of fostering and improving education in foundry science, engineering, and operation. At the present time the foundation offers scholarship opportunities at 17 universities throughout the nation.

Applicants for the Wheelabrator Fellowship Program will be encouraged to take graduate study in engineering, science, or business administration at one of the affiliated universities. Applicants in other fields and at other schools will be considered if the graduate study requested has an immediate connection with the foundry industry and is likely to benefit the cast metals industry to a significant degree. First recipients of the award will begin study in the Fall of 1958.

Frozen Memory Unit Developed For Computers

LOW TEMPERATURE physics research work being conducted by Ramo-Wooldridge Corp. has resulted in the development of a high speed computer memory element which makes use of low temperature superconductivity principles to achieve both storage of information and instantaneous switching. The



INCOMING inspection of transformers, relays, resistors, transistors, and similar items is performed automatically by a new tester manufactured by California Technical Industries. Single hole punched in the transformer section of the program card schedules tests for primary impedance, winding ratio, and winding polarity. By punching other holes, the values and tolerances for the transformer may be specified. Tests are made on a go/no-go basis and the tester indicates the type of fault encountered or signifies "Complete" at the end of a test series. Circuitry is included for use with automatic handling equipment.

Circle 664 on Page 163

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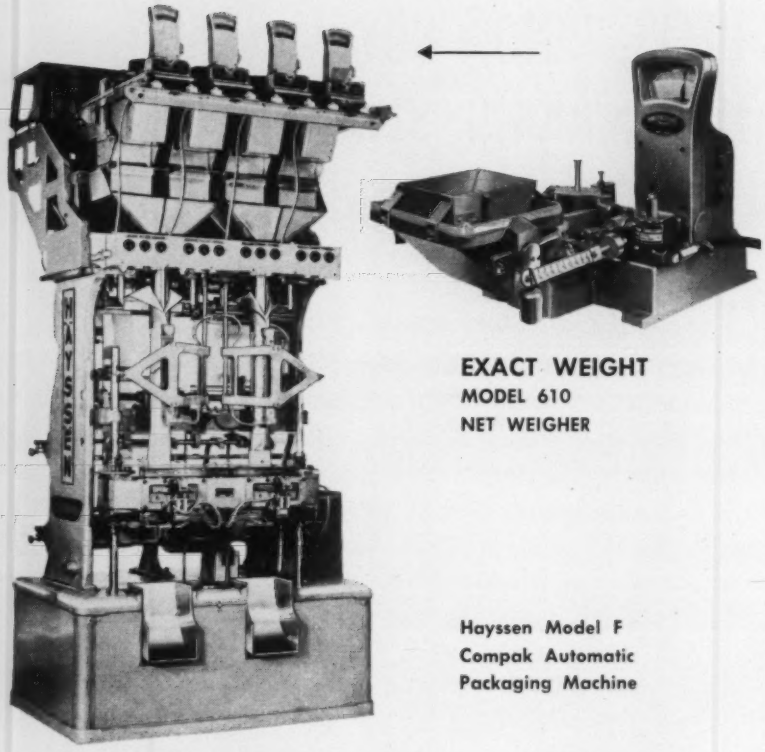

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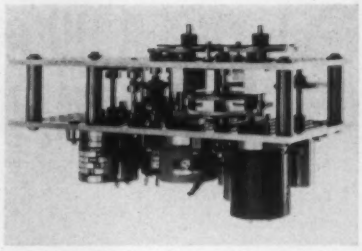


INSTRUMENT construction system has been developed by Gap Instrument Corp. to reduce time and cost in the development of pilot model servo systems. The new system enables Gap to go from a rough schematic diagram to a compact finished unit suitable for field use in a very short time. The example shown is an elevation and azimuth rate-position servo used in a Signal Corps moon position prediction computer. Past experience indicated that approximately 300 hours expended over a 9-10 week period would be required to produce the elevation unit. Application of the system to this problem cut the expended hours to 35 and the elapsed time to 3 days.

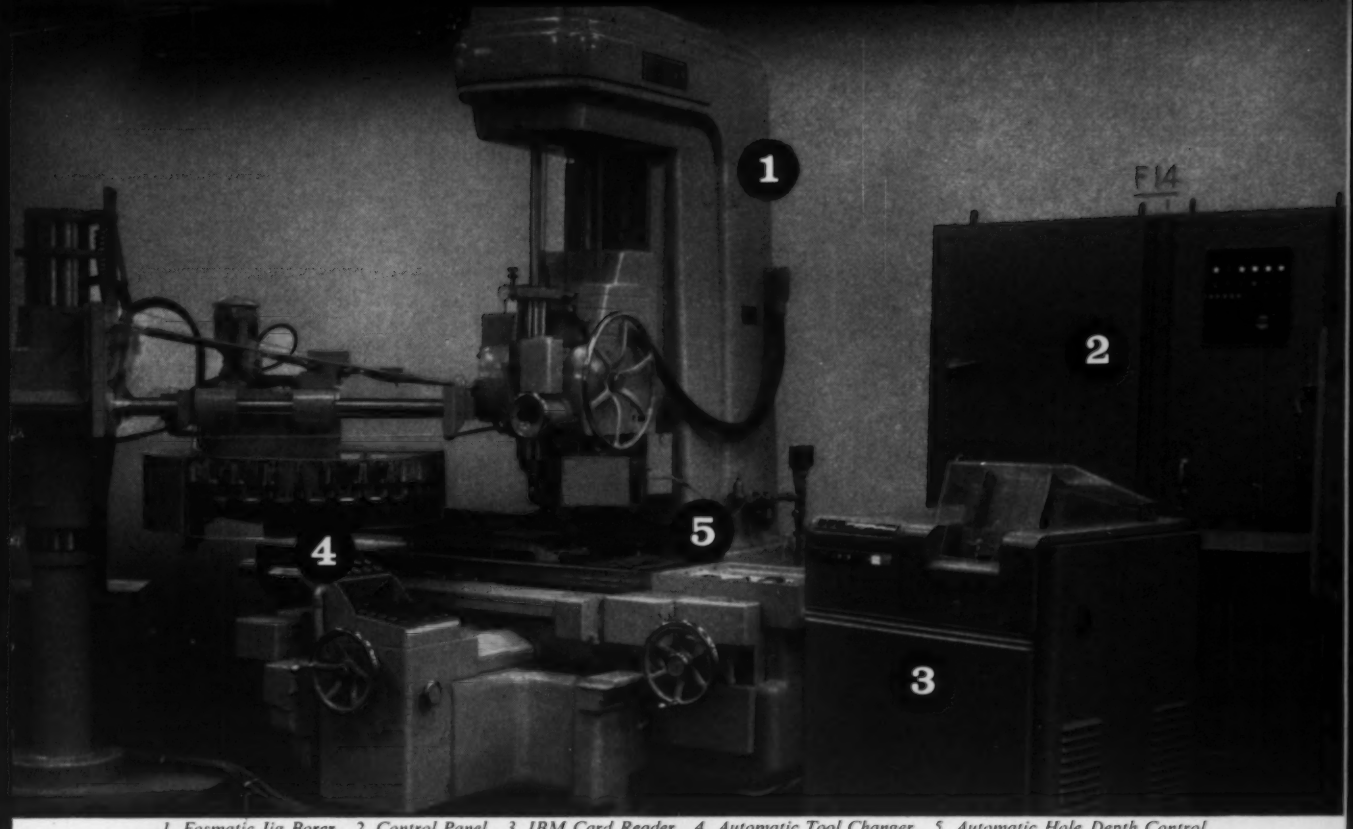
new device is called a Persistor and is a miniature, bimetallic, printed circuit which operates at a temperature within a few degrees of absolute zero.

The Persistor is a loop composed of segments of two metals, both of which are maintained in a superconductive state at a very low temperature. One segment of the loop is of a metal so chosen that the passage of a small current through it causes it to change from its superconductive to its normal resistance state. A subcritical current is induced in this loop and continuously circulates around it for an indefinitely long period. The direction of this current represents the information being stored and is determined at any time by impressing an interrogating current pulse on the loop. The direction of the current in the Persistor is clearly indicated by the presence of a voltage pulse upon interrogation.

Ultrasonic Fluid Measurement

ULTRASONIC systems for external measurement of pressurized liquid within a pipe have been proposed by Navy researchers. Formulations for the flowmeters are described in a report recently released to industry through the Office of Technical Services, U. S. Department of Commerce.

The research was undertaken



1. Fosmatic Jig Borer 2. Control Panel 3. IBM Card Reader 4. Automatic Tool Changer 5. Automatic Hole Depth Control

World's first totally automatic jig borer--by Fosdick

Now, any jig boring operation can be completely programmed and controlled by punched cards and tapes. This total automation is available only on the Fosmatic Jig Borer, developed by Fosdick and the International Business Machines Corp.

HERE'S HOW IT WORKS: Once workpiece is loaded on the jig borer, the following functions are controlled completely automatically —

Table and saddle locations
Spindle feeds and speeds
Feed depth
Spindle head height
Automatic tool changing

Dimensions, feeds, speeds, etc. are charted by your Production Engineering Department, then tape or cards are punched (a simple clerical procedure). Optimum programming can be achieved by using an automatic computer to establish the best possible sequence of operations. Hole size and location are accurate to ±.0001", hole depth within .002".

SELECT THE DEGREE OF BORING AUTOMATION YOU NEED. The above numerically controlled functions are available individually or as a group. By controlling table and saddle location only, your engineers can establish optimum work sequence (eliminates leaving decisions to the operator). By adding the other numerically controlled functions, you further eliminate errors and lost time. On single piece jobs, as well as precision production runs the result is lower cost per piece, considerable savings in set-up time and inventory, greater flexibility in scheduling. Often, jigs and fixtures are eliminated, with their high cost and lead time.

A meeting with your Fosdick representative will help you quickly determine just how these dramatic new methods can best serve your production needs. Write for Bulletin NC-P.

Need boring equipment? Get a proposal from Fosdick!

FOSDICK

THE FOSDICK MACHINE TOOL CO., CINCINNATI 23, OHIO

Circle 666 on Page 163

position or feed it faster

WITH AN AUTOMATIC

Feedall

hopper-load elevating feeder eliminates costly hand operations, saves time and speeds parts flow

SPECIFICATIONS—*Model 3000 Elevating Hopper Feed*

FEED RATE: variable speed drive to match production rate of machine being fed.

WORK RANGE: rolling parts, 1" to 6" in diameter, 1/8" to 2" in length. Sliding parts, 1/8" to 2" in diameter, up to 6" long. Loading height is 62".

CAPACITY: 18 or 25 cu. ft. hopper Overall floor space is 48" x 52".

DELIVERY ANGLE: 15° rolling parts, 30° sliding parts. 10° elevating angle.

DRIVE: 3/4 hp, 220/440V 60 cycle, three phase motor.

This multi-purpose feeder is just about the most versatile machine ever developed by Feedall. It provides in-process storage; elevates, orients and feeds work-pieces of wide variety in diameter and length. It handles both rolling and sliding parts. Typical are the varied parts shown above, merely suggesting the many versatile uses for this high-production unit.

It's fully automatic. Model 3000 replaces slow, time-wasting hand feed. The combination of magazine-loading and selectable speed permits continuous parts flow at any desired rate. *It's compact.* The "complete-package" feeder is entirely self-contained and is simple to fit into existing facilities. *It's a producer.* Model 3000 has proved its reliability and profitable operation in scores of installations. Construction is rugged; built for multi-million cycle operation.

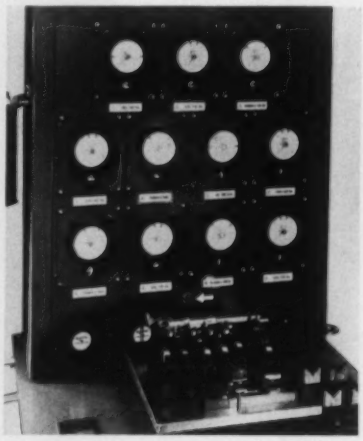
Useful features of the Model 3000 include: electronic controls for any timing cycle, readily adaptable design to fit many special feeding jobs, portable and simple to re-locate, and adjustable elevating angle for special purposes.

Eliminate hand-feed, save operators and step-up production . . . with a Model 3000 Feedall. Full details are available in latest catalog, complete with estimating data sheet. Write for your copy today. Or if you have a special feeding problem, send us sample parts and brief data. We'll do the rest, promptly.

Feedall *Producers of automatic feeding devices*
FEEDALL, INC., WILLOUGHBY, OHIO

ELEVATING, BLADE, TUMBLE, VIBRATORY FEEDERS • TRANSFER AND ELEVATING CONVEYORS • SPECIAL SELECTOR DEVICES

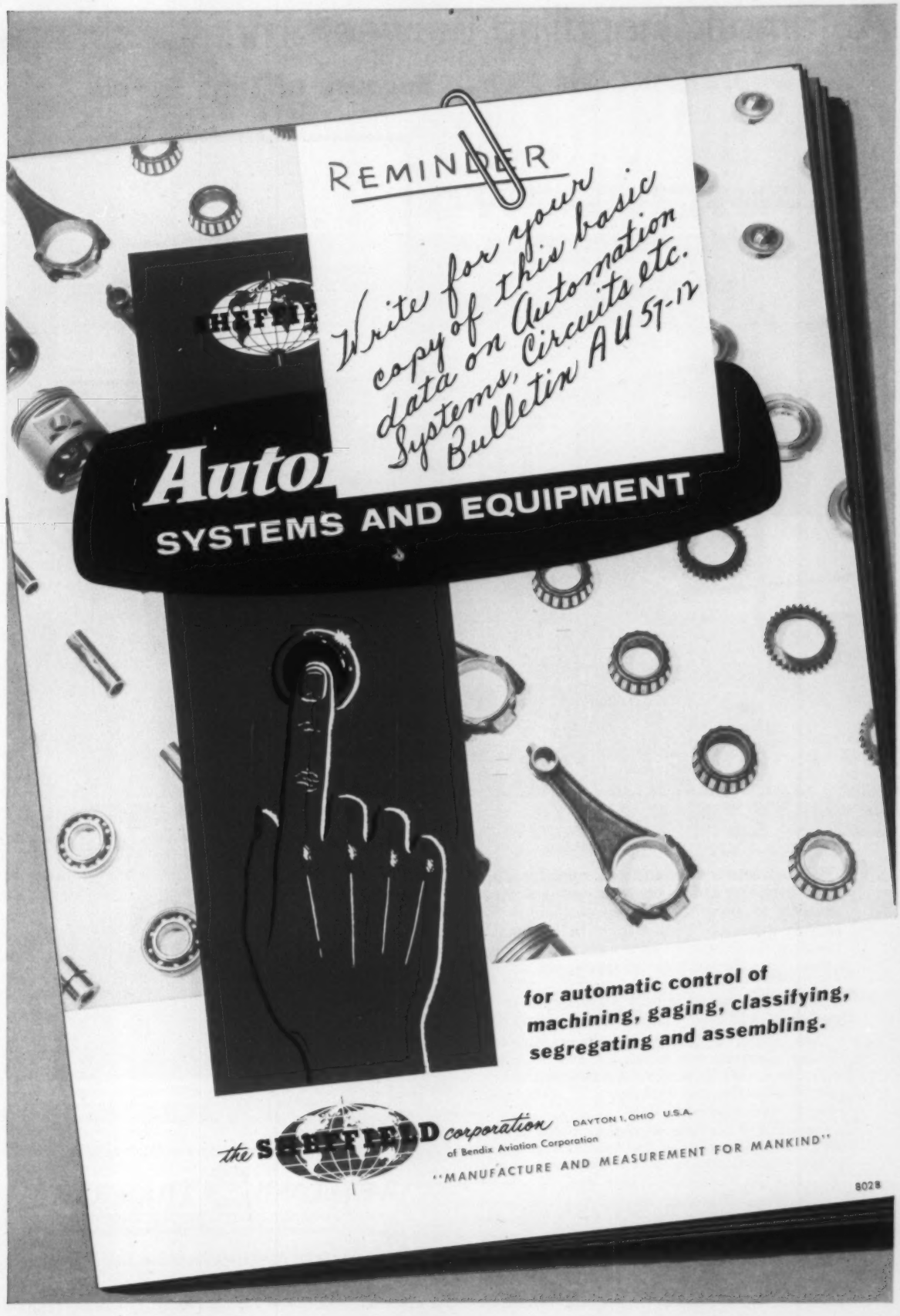
after a literature survey disclosed no proved ultrasonic scheme in which the sound energy traverses fairly thick metal walls between sound source and receiver and the liquid. A flowmeter operating through the pipe walls could be used where the liquid is corrosive or under high pressure or temperature. The report describes three proposed configurations for the flowmeter along with a block diagram of a suggested electronics system. Also included is a scheme for mechanical construction of two configurations.



MULTIPLE dimension gaging system has been developed by Federal Products Corp. Unit shown consists of eleven modular air-electric meter switches which are arranged so that the operator is required to observe only one large signal light to determine if a multiple dimension part is within tolerance. Each individual meter unit in the system is equipped with two lights which signal an off-size dimension—red for scrap and yellow for salvage. Indicator dials on the individual meter units will also show operator the exact amount of deviation from specified tolerance.

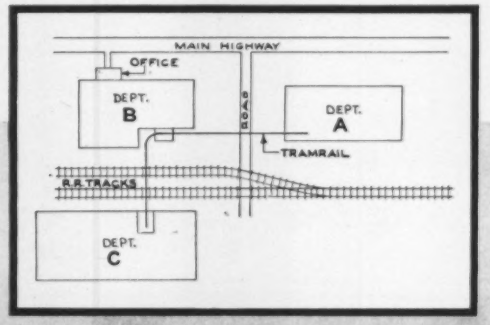
SPOTLIGHTING PEOPLE

Vincent Kaye appointed director of research and development for Control Engineering Co. . . . **Claude B. Nolte** appointed vice president in charge of product engineering and development and **Everette M. Furr** named factory superintendent of Barton Instrument Corp. . . . **John J. Graham** appointed manager, Operations Administration, Industrial Electronic Products, Radio Corporation of America . . . **J. Lee Ferguson Jr.** elected chairman of the board for J. L. Ferguson Co. . . . **Harry G. Hilk** appointed general superintendent of the Chicago Plant of Clear-

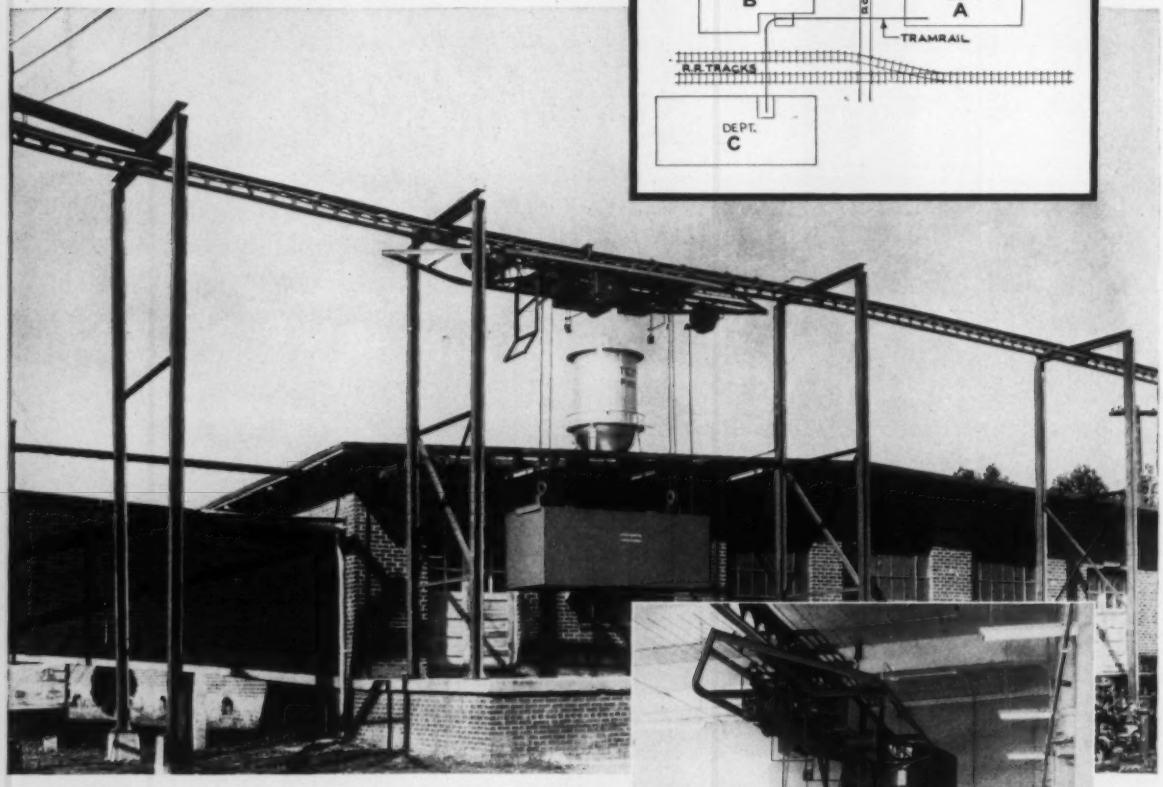

REMINDER
Write for your copy of this basic data on Automation Systems, Circuits etc. Bulletin AU 57-12
SYSTEMS AND EQUIPMENT
for automatic control of machining, gaging, classifying, segregating and assembling.
the SHEFFIELD corporation
DAYTON 1, OHIO U.S.A.
of Bendix Aviation Corporation
"MANUFACTURE AND MEASUREMENT FOR MANKIND"
8028

Automatic Handling Between Three Buildings

Operation Costs Plunge Because of Time Saved



Photograph shows van being lowered to outside dock. It remains here until unloaded or loaded and dispatched.



AN automatic Cleveland Tramrail materials handling system operates over a street and railroad to serve three separate buildings. It carries materials back and forth between the plants without need of especially assigned operators. The dispatching of materials is easily handled by men in the buildings along with their other work, since it is only necessary to press a push button to send a Tramrail carrier on its way.

The Tramrail carrier travels up and down grades because the buildings are at different elevations. When it reaches its destination, it lowers at once, automatically. A warning bell sounds as it descends.

Because of the time savings and elimination of need of many powered floor trucks and their expensive maintenance, cost of handling materials between the buildings is very low.

Cleveland Tramrail has engineered a wide variety of automatic materials handling systems. We stand ready to share with you the benefit of our experience.

Loading a Tramrail carrier van with four floor trucks. Each has a load of 250 lbs. Depressing the proper button on the wall sends the van to either of the other two buildings.

Write for free "Automatic Handling" booklet.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1336 E. 290 ST. • WICKLIFFE, OHIO

Circle 669 on Page 163

MERCURY-ACTUATED indicating temperature control is designed for all types of industrial applications and is offered by Partlow Corp. Accurate to within 0.5 per cent of scale range, the controller will sense, indicate, and control processes and appliances between temperature ranges of —30F to 1100F. It is available in ten different scale ranges and is equipped with a magnifying pointer having two hairlines for parallax sighting.

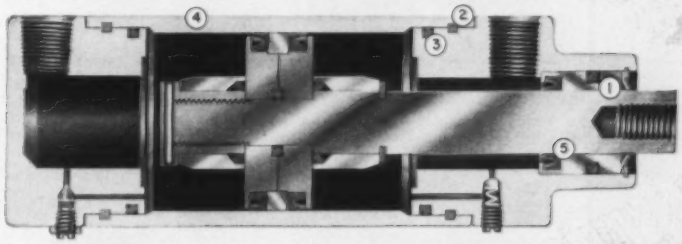
---

ing Machine Corp. . . . **Calvin A. Burton** appointed assistant to the vice president of systems for Lamson Corp. . . . **Dr. Cuthbert C. Hurd,** director of automation research for International Business Machines Corp., elected president of the board of trustees of the Foundation for Instrumentation Education and Research . . . **A. James Edwards** appointed general sales manager for Electro Precision Corp. . . . **Walter C. Weber** appointed consultant on automatic production equipment for Standard Tool & Mfg. Co. . . . **Lester V. Wise** appointed head of production and new products division of Federal Business Products Inc. . . . **Howard H. Deem** appointed director of manufacturing for both Valvair Corp. and Sinclair-Collins Valve Co. . . . **Clarence Dykstra** appointed sales manager for the Spanmaster Crane Div., Jervis B. Webb Co. . . . **Donald W. Gunther** named manager of the Youngwood Semiconductor Plant of Westinghouse Electric Corp. . . . **Richard A. Shaw** named chief engineer of Neff Instrument Corp. . . . **William H. Saylor** appointed product manager of industrial control work of Norden-Ketay Corp. . . . **Albert D. Unetic** appointed general manager of the Acro Div., Robertshaw-Fulton Controls Co. . . . **Everett Gravenhorst** appointed director of engineering for the Fluid Systems Div., Waldorf Instrument Co. . . . **Dr.**

CARTER

CYLINDERS

AIR OR HYDRAULIC



Designers get 3 Important Benefits by Standardizing on the Superior CARTER Design

THE CARTER DESIGN

1—Full 1 to 1 Meehanite cartridge rod bearing.

2—Key type stainless steel locking ring. Allows 360° rotation of ports.

3—Leakproof "O" Ring seal between head and wall.

4—Precision honed heavy wall tubing—6 to 1 safety factor.

5—Spring loaded "V" packing on rod end gland.

IMMEDIATE DELIVERY FROM STOCK

SAVINGS IN SPACE—40% savings in space. Helps build more compact, functional equipment. Where other cylinders won't fit, Carter will!

IMPROVES PRODUCT QUALITY Carter cylinders are stronger, more efficient. Completely leakproof! Better performance, longer life. The finest cylinder for your product.

ENGINEERING SERVICE and sales in 40 locations throughout the United States, Canada, Mexico, and Europe.

FREE DESIGNERS' FILE

Details on air, hydraulic, valves, built-in-valve types. All necessary data for designers.

CARTER **CONTROLS INCORPORATED**

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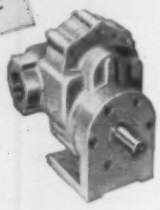
AIR CYLINDERS • AIR VALVES • HYDRAULIC CYLINDERS
ROTARY ACTUATORS • SPECIAL CONTROLS

Circle 670 on Page 163

ADEL *Industrial Hydraulic Equipment*

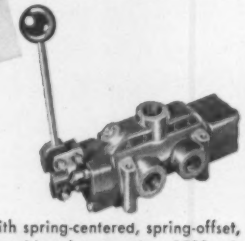
for PEAK PERFORMANCE ADEL Hydraulic Valves and Pumps are setting new and ever higher standards for precision in manufacturing and efficient performance in operation. Following are but a few of the wide variety of models to meet all operating conditions.

GEAR-TYPE HYDRAULIC PUMPS



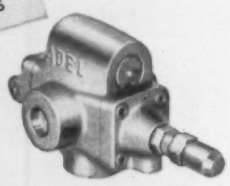
For 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 46.8 gpm.

DIRECTIONAL CONTROL VALVES



4-way valves with spring-centered, spring-offset, and 1, 2, or 3 position detent action. 1500 psi. Flows to 28 gpm.

BY-PASS VALVES



Relief, Sequence and Unloading valves. Direct or remote operation, 50 to 1500 psi range.

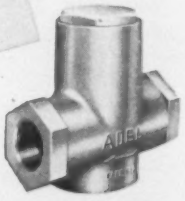
VOLUME (FLOW) CONTROL VALVES

Compensated type maintains constant flow over wide differential pressure range. No drain line required. 1500 psi.

PILOT VALVES

2 or 3 position detent. With or without dog or lever. Can be used as 4-way valve in small circuits. 1000 psi.

CHECK VALVES



Valves allow free flow in one direction only. Many variations available. 3000 psi.

Reliability

ADEL PRECISION PRODUCTS

A DIVISION OF GENERAL METALS CORPORATION

HUNTINGTON, WEST VIRGINIA

Manufacturers of MARINE & INDUSTRIAL HYDRAULIC CONTROL EQUIPMENT

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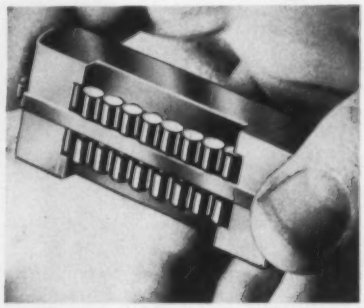
RHODE ISLAND
Lincoln Supply Company
Pawtucket, Rhode Island

TEXAS
Air-Draulic Equipment Company
Houston, Texas

UTAH
Robert Taylor & Sons
Salt Lake City 10, Utah

WASHINGTON
Russ Chamberlin Company
Seattle, Washington

Winston E. Kock named general manager of the Research Laboratories Div., Bendix Aviation Corp. . . . **George A. Kendall** appointed divisional president and general manager of Wickes Corp. . . . **Markus M. Epstein** appointed chief engineer of Control Electronics Co. Inc. . . . **E. J. van Dyk** appointed general manager of Control Devices Inc. . . . **Carter L. Burgess** elected president of American Machine & Foundry Co. . . . **Nathaniel B. Nichols** appointed vice president and chief engineer of Taylor Instrument Co.



ROLLER way-bearings manufactured to close tolerances for use in precision machine tool slides are available from Tycho Mfg. Co. The new bearings will eliminate the stick-slip characteristic of slides and will provide unlimited travel with constant accuracy. High unit capacity is obtained through the use of 52100 steel in all load carrying parts.

SPOTLIGHTING PRODUCTS

Silicon photo-voltaic cells, which have a response time of less than 20 microseconds, have been developed by the Semiconductor Div., Hoffman Electronics Corp. The cells are self-generating, require no external power supply, and applicable for punched tape and card readouts, programming controls, pinhole detection, remote switching controls, infra-red sensing, automatic counting, and heat detection . . . *High temperature magnet wire* for relay use has been developed by Secon Metals Corp. One type has a bonded refractory insulation rated for continuous use at 700F and intermittent use of 800F. A second type has a ceramic insulation rated for continuous use at 1000F . . . *Diffused base transistor* which operates at high speeds unattainable by germanium-alloyed types is commercially available from General

Circle 671 on Page 163

GREENLEE TRANSFER MACHINES

Change with Your Requirements

THIS MACHINE HAS BEEN REWORKED FOUR TIMES

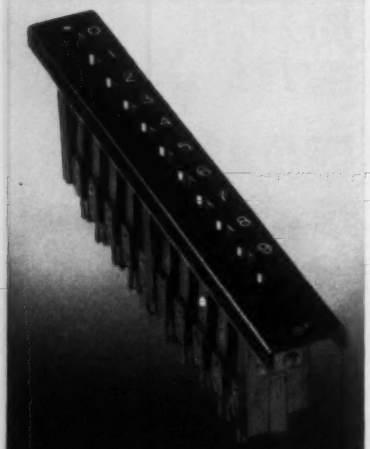
The "building block" idea of machine tool design has gained much popularity in recent years. Greenlee has long built such flexibility into their transfer machines. For example, the machine shown here has been modified 4 times in 11 years to accommodate changes in product design. Protect yourself from costly obsolescence. Ask Greenlee to show you how.

PHONE ROCKFORD, ILLINOIS 3-4881
TO HELP SOLVE YOUR PRODUCTION PROBLEMS

GREENLEE
BROS. & CO.

2084 MASON AVE.
ROCKFORD, ILLINOIS

STROMBERG-CARLSON



PUSH-KEYS
now available with
automatic interlock

In such precision operations as automation programming, you can now eliminate the risk of pushing more than a single button at a time.

This new interlock feature is based on a simple arrangement of sliding cams. Only one button at a time can be depressed. This feature is available in all multiple-pushbutton assemblies (7, 10, 12 and 20 button arrangements).

All "telephone-quality" advantages of Stromberg-Carlson keys continue as before. You may apply "make," "break," "break-make" and "make-before-break" combinations as required. You get standard spring combinations with Form A, C or D contacts—or you may order special strips of keys with intermixed contacts.

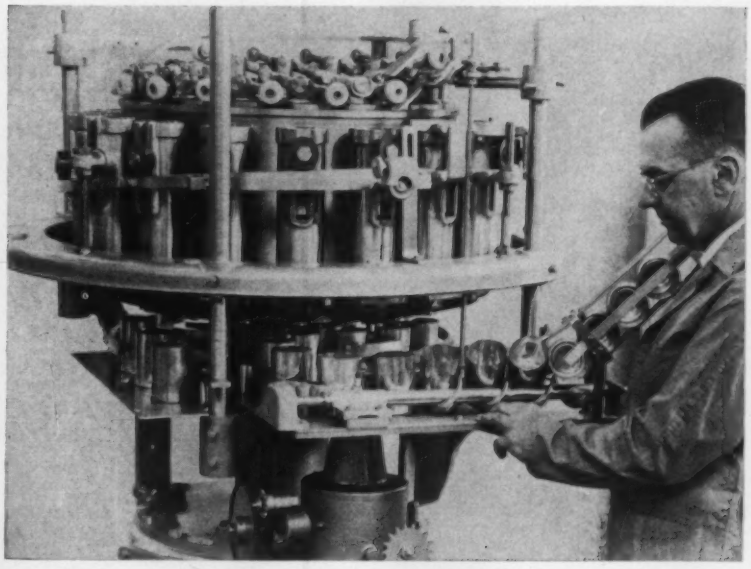
Buttons are available in white or colors—blank or with letter or number designations.

For complete technical data on Stromberg-Carlson Key Switches send for our illustrated Bulletin T-5002R.

S-C
STROMBERG-CARLSON

STROMBERG-CARLSON
A DIVISION OF GENERAL DYNAMICS CORPORATION
Telecommunication Industrial Sales
111 Carlson Road, Rochester 3, N. Y.
Electronic and communication products for home, industry and defense

Circle 673 on Page 163



RIGHTS to manufacture a liquid filler machine have been purchased by Girdler Process Equipment Div., National Cylinder Gas Co., from Librascope Inc. The machine will be built in various models with up to 36 stations and with both piston and gravity type fillers. The 18-station, piston-type unit shown can be used to fill a variety of containers with materials such as soup, jelly, crushed fruit, petroleum products, liquid detergents, and baby foods. Depending upon the size and type of machine, production of up to 1000 containers per minute is possible.

Transistor Corp. The drift transistor differs from its germanium-alloyed counterpart in that the emitter side of the base region has a greater impurity concentration than the collector side. This creates a built-in field which drives the charge carriers across the base region at a faster rate and enables the transistor to operate at higher frequencies. The unit has numerous electronic applications including use in television circuits, short wave radio, high frequency oscillators, and very high speed switching computers . . . *Electronic circuit sentry* designed to minimize damage to power-system equipment and improve service to customers by reducing disruption of current supply has been developed by Radio Corp. of America. The new unit is a fast-acting transistorized device utilizing the transmission of a tone signal to set in motion a series of relays which, in twelve thousandths of a second, actuate circuit breakers and isolate faulty high-voltage lines. The transistorized devices are operated by a utility's standard fault-sensing relays. Upon detection of a fault in a power line, the relay transmits a tripping signal to its associated circuit sentry transmitter. The latter instantly transmits the signal to all necessary sentry receivers which isolate the damaged line from the network.

SPOTLIGHTING PLANTS

Conveyor Systems Inc. has occupied a newly constructed plant and office in Morton Grove, Ill. where it will manufacture special materials handling equipment as well as wheel and roller gravity conveyors, portable belt units, and overhead trolley conveyors . . . **Haydon Instrument Co.** is a new concern which will design and manufacture proprietary electromechanical devices such as high speed numeral counters and printed circuit motors . . . **Lewis-Shepard Products Inc.** has added 75,000 square feet to its Watertown, Mass., plant for the assembly of fork lifts, walkie-type trucks, and electrohydraulic stacking equipment . . . **Bryant Chucking Grinder Co.** has become a subsidiary of Ex-Cell-O Corp. and will continue to manufacture machine tools, thread and groove gages, surface plates, and components for computer systems in its new capacity . . . **Composite Forgings Inc.** has created a Special Machine and Fabrication Div. to design, fabricate, and construct

RIVETT SQUAREMASTER "100" CYLINDERS

Unfailing POWER for MILLIONS of cycles!

Here's sure power for unfailing cylinder operation. SQUAREMASTER 100's are the world's finest constructed cylinders—perform with 100% efficiency! 200 P.S.I. air to 500 P.S.I. oil. Available in 7 mountings with standard dimensions, in 10 bore diameters, internal and external threading. Special models and cover combinations. Priced competitively; prompt delivery; meet all J.I.C. requirements.

RIVETT, INCORPORATED

Dept. AU4, Brighton 35, Boston, Mass.

*Initial High Coefficient of Static Friction

POWER-PACKED FEATURES PROTECTED BY POWER-GUARD CONSTRUCTION

1. Piston rod. Ground and polished alloy steel. Hard chrome-plated. **2.** Piston rod bearing. Replaceable cartridge-type. **3.** Piston packing adjusts automatically. V-block packing minimizes friction. **4.** Correctly stressed tie rods. **5.** Cushion bushings. Bronze, floating type. **6.** Ports rotated to any 90° position. **7.** Steel covers. Take minimum mounting space.

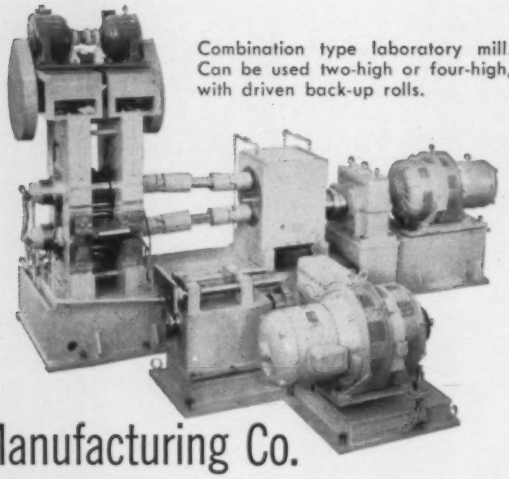
Send for catalog. Proof of SQUAREMASTER efficiency stated in these 20 pages. Write today.

RIVETT furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

Member — National Fluid Power Association

Circle 674 on Page 163



Combination type laboratory mill. Can be used two-high or four-high, with driven back-up rolls.

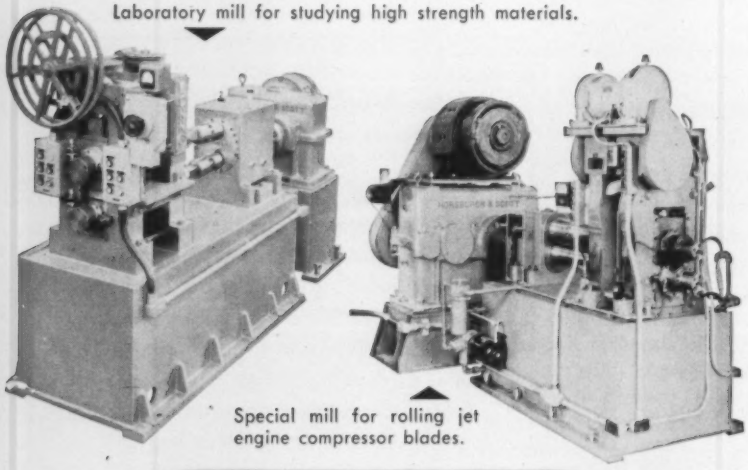
Why Fenn Manufacturing Co. equips its precision rolling mills with **H & S** Speed Reducers and Gears

Manufacturers of precision metal forming equipment, the Fenn people necessarily must buy carefully when selecting components from other sources. When it comes to speed reducers and worm and gear sets, they rely on *Horsburgh & Scott.*

The Fenn rolling mills illustrated here are built to order for both production and laboratory use. H & S Speed Reducers are in evidence, sized to suit the need. H & S worm and gear sets are used in the screw down mechanisms.

The rugged dependability of H & S products, helpful and flexible engineering service, and reliable delivery performance are principal values in a continuing profitable relationship . . . There's a solution to *your* power transmission problem in the broad lines of gears and assembled units made by H & S. Write us, or contact your nearby H & S representative.

Laboratory mill for studying high strength materials.



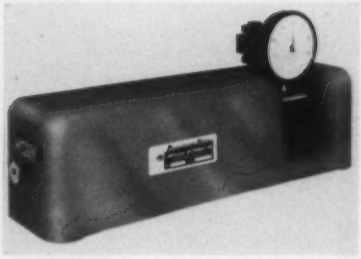
Special mill for rolling jet engine compressor blades.

THE HORSBURGH & SCOTT CO.

GEARS AND SPEED REDUCERS

5112 Hamilton Avenue

Cleveland 14, Ohio



EXTREME pressure gage which measures pressures up to 100,000 psi has been announced by the American Instrument Co. Inc. The instrument is fitted with a dial face marked with 100 divisions, each of which represents 1000 psi. Gage features a heavy-walled, chrome-nickel molybdenum pressure tube which tends to curve under pressure and actuates the dial gage. Entire pressure tube is surrounded by a cast iron case with a sheet metal back. In case of accidental overload, the sheet metal back absorbs the bursting energy and protects the operator.

heavy duty machines and automation equipment . . . **Parker-Hannifin Corp.** has combined its Parker Rubber Div. and its Franklin C. Wolfe Div. into a new division called the Parker Seal Co. which will specialize in the manufacture and sale of a wide range of rubber and metal seals for fluid systems . . . **National Pneumatic Co. Inc.** has acquired Connecticut Telephone & Electric Corp., manufacturers of telephone and electronic equipment . . . **American Measurement & Control Inc.** has been recently formed for the purpose of developing and manufacturing products in the instrument and control field . . . **Design** is the name of a firm entering the automation field which will specialize in the design and fabrication of orientation and feeding mechanisms.

MEETINGS AND EVENTS

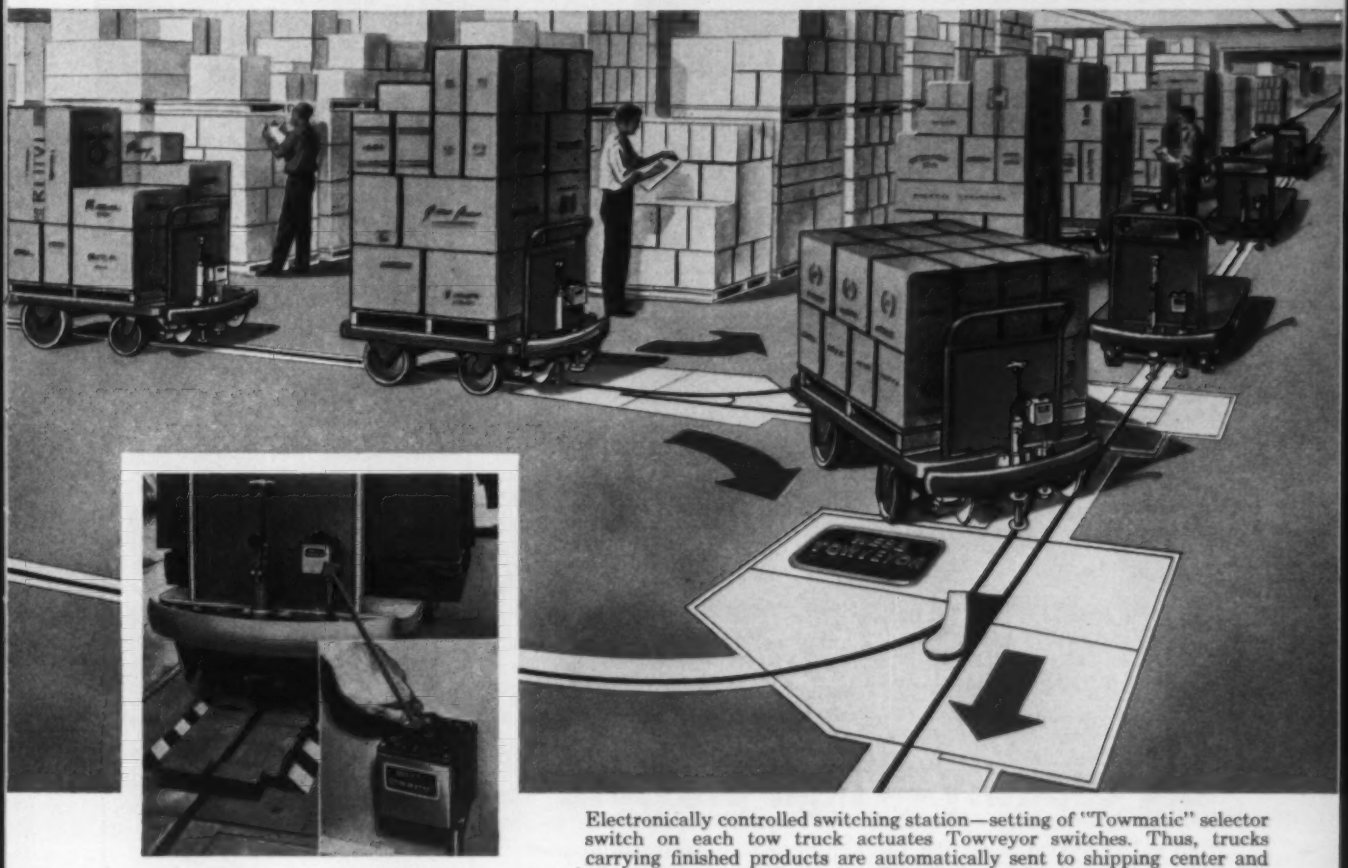
April 14-16—

First Joint Conference on Automatic Control Techniques. Meeting is sponsored by AIEE, ASME, and IRE, and will be held at Hotel Statler, Detroit. Additional information is available from R. M. H. Berg, 330 West 42nd St., New York 36, N. Y.

April 14-17—

American Society of Mechanical Engineers. Annual Design Engineer-

FIRST Electronically Controlled Towveyor . . .



Electronically controlled switching station—setting of "Towmatic" selector switch on each tow truck actuates Towveyor switches. Thus, trucks carrying finished products are automatically sent to shipping center and all other trucks are diverted to Towveyor at right.

Slashes Handling Costs . . . Prevents Traffic Snarls . . . Speeds Production

Johnson & Johnson, in designing their "Plant of Tomorrow", gave major consideration to efficient materials handling. Required was a handling system providing: lower handling costs—smoother traffic flow—increased production—reduced manual handling—integration of materials movement in and between three buildings—automatic delivery of a variety of materials to many locations.

After intensive study of a number of handling methods, J & J selected a Webb electronically controlled Towveyor as their basic materials handling system . . . it filled their requirements.

In fact, all materials handling, in the two manufacturing buildings and shipping, centers around this 3624 foot Towveyor. To provide electronic control for movement of materials, each tow truck is equipped with a 19-station Towmatic selector switch—each station representing a different location in the plant. Thus, by simply flipping Towmatic switch to desired station and lowering tow pin into Towveyor slot, the tow truck is started on its way—electronics take over and materials automatically travel to their destinations.

Two other Towveyors located in shipping center wind through order-picking areas to provide at-hand-convenience for personnel filling customer orders. Towtrucks carrying filled orders are placed on these Towveyors for unescorted travel to loading dock. By automatically performing the multiple materials handling operations required in manufacturing, warehousing and shipping, Towveyors at J & J reduce manual handling—lower operating costs—speed production.

JERVIS B. WEBB COMPANY
SPECIALISTS IN CUSTOM CONVEYOR SYSTEMS
8945 ALPINE AVENUE • DETROIT 4, MICHIGAN

FACTORIES: DETROIT • LOS ANGELES • ATLANTA • HAMILTON, ONT., CANADA • ENGLAND • FRANCE • BELGIUM • AUSTRALIA

For a detailed description of the Johnson & Johnson Towveyor system and its many benefits, write for 12-page Bulletin 28.

Webb in-floor Towveyor and overhead Tow-Conveyor systems are completely described and illustrated in Catalog 157—write for your free copy.

Circle 676 on Page 163

CONSIDER THESE OUTSTANDING FEATURES...

- Internal Parts—Stainless steel—give long, trouble-free service
- Coil—Continuous duty—10 watts max.—UL-approved
- Body—Forged brass—dense metal structure
- Mounting—Direct-line—can be serviced without removal from the line
- Options—Explosionproof, Manual Override, Electrical

SKINNER'S NEW 2-WAY VALVE OFFERS

big capacity — high pressure

Here's the second new line of valves designed to answer your control "puzzles." This new line, called the R Series, is a two-way, pilot-operated piston valve with ¼" orifice and ¼" NPT. It is available normally open or normally closed and operates on a pressure differential of 5 to 200 PSI. This new R Series also includes an Explosionproof line in normally open and normally closed construction. A normally closed version will be available soon to operate on pressures up to 1000 PSI.

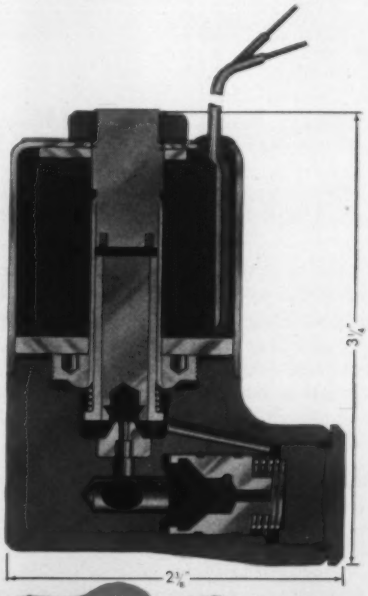
This new R Series uses the famous Skinner V5 Operator and will control air, water, oil and semi-corrosive media. The normally open version can, on request, be supplied with pilot exhaust piped to body outlet port.

A wide selection of coils—high-temperature, waterproof and standard—for common AC and DC voltages is available, and there is choice of electrical connections such as Automotive Terminals, Grommet and Conduit.

The temperature range of this new line is −65° to 180°F Ambient, and −65° to 150°F Media. It is light in weight—only 1¼ pounds—and can be mounted directly to the line by means of the ¼" NPT. Distance between ports is 2 inches.

* * *

For complete information about this new line of Skinner valves, please contact our Representative or Distributor near you—you'll find him listed in the Yellow Pages. Or write us at the address below, Dept. 324.



SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

Circle 677 on Page 163

ing Conference and Show to be held at the International Amphitheatre, Chicago. Further information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

April 14-18—

American Welding Society. Annual technical meeting to be held at Hotel Statler, St. Louis. Annual Welding Show to be held at Kiel Auditorium, St. Louis. Further information is available from Robert T. Kenworthy, 12 East 41st St., New York 17, N. Y.

April 21-23—

Metal Powder Association. 14th Annual Meeting and Powder Metallurgy Show to be held at the Sheraton Hotel, Philadelphia. Additional information is available from Kempton H. Roll, MPA headquarters, 130 West 42nd St., New York 36, N. Y.

April 22-24—

Electronic Components Conference. Meeting to be held at Ambassador Hotel, Los Angeles, with conference theme of "Reliable Application of Component Parts." For further information contact David M. Knox, Packard-Bell Electronics Corp., 12333 West Olympic Blvd., Los Angeles 64, Calif.

April 28-May10—

Industrial Management Center. First Annual Industrial Packaging Training Conference to be held at Lake Placid Club, Essex County, N. Y. Additional information may be obtained from James R. Bright, Industrial Management Center, 56B Robbins Road, Lexington, Mass.

May 1-8—

American Society of Tool Engineers. 26th Annual Meeting and Tool Show to be held at Philadelphia Convention Center, Philadelphia. For further information contact Richard Gebers, Public Relations Manager, 10700 Puritan, Detroit 38, Mich.

May 6-8—

Western Joint Computer Conference. Meeting cosponsored by IRE, AIEE, and Association for Computing Machinery to be held at Ambassador Hotel, Los Angeles. Additional information is available from David Parry, 6363 Wilshire Blvd., Los Angeles 48, Calif.

May 7-17—

United States World Trade Fair. Exposition of industrial and consumer commodities to be held at the Coliseum, New York. Further information is available from U. S. World Trade Fair, 331 Madison Ave., New York 17, N. Y.

May 8-10—

American Material Handling Society. Western Material Handling Show sponsored by the Los Angeles Chapter of AMHA to be held at the Great Western Exhibit Center, Los Angeles. Additional information is available from Joe Druliner, 2807 Sunset Blvd., Los Angeles 26, Calif.

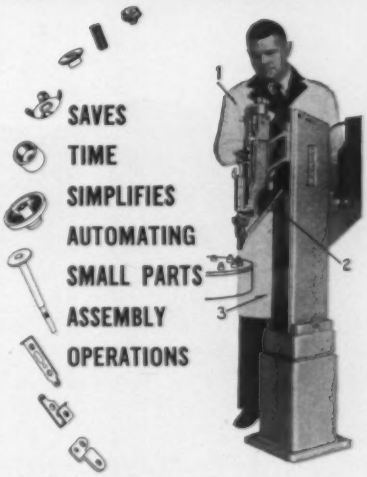
May 12-14—

Instrument Society of America. Annual Symposium of the Analysis Instrumentation Div. to be held at Shamrock Hilton Hotel, Houston, Tex. Further information is available from H. S. Kindler, ISA Director of Technical Programs, 313 Sixth Ave., Pittsburgh, Pa.

May 26-29—

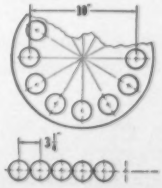
American Management Association. National Packaging Exposition to be held at the Coliseum, New York. National Packaging Conference to be held concurrently at Hotel Statler, New York. Additional information is available from Donald G. Keen, Press Relations Director, 1515 Broadway, New York 36, N. Y.

New Standard DIXON Auto-Positioner



AUTOMATICALLY GUIDES PARTS OF 1/16" TO 3" O.D. SIZE AT RATES UP TO 6,000 PER HOUR

The new Dixon Auto-Positioner combines three standardized units—(1) Automatic Air-Operated Positioner, (2) Automatic Escapement, (3) Mounting Structure. Because the unit is compact and fits into small space, it provides an economical solution for a wide range of small parts assembly. It has an exclusive sensing feature that automatically stops your machines when parts are missing or malformed. Auto-Positioners are easily arranged at single or multiple stations with feeders, feed tracks, transfer or indexing tables. With properly tooled chucks, positioning punch, and proven feeder, parts are positioned at rates up to 6,000 pieces per hour. Individual units or any combination of standard components available from stock. Tooled Auto-Positioners provided to suit needs.



May be located at adjacent stations, only 3¼" apart for straight-line indexing, or on 12-station dial with a 5" fixture radius.

WRITE FOR FREE DATA SHEETS
New bulletins supply specifications and application data on standardized units now available from stock.

DIXON AUTOMATIC TOOL, Inc.
2312–23 rd AVENUE
ROCKFORD, ILLINOIS
Equipment for Automatic Parts Handling and Assembly

Circle 678 on Page 163

Introducing the revolutionary new MAC 4-way

DUAL-

Feature spool-within-a-spool design . . . operate with unmatched efficiency . . . sell for about half the price of most other ½" to 1¼" valves . . . meet all J.I.C. specifications

Designed around a revolutionary spool-within-a-spool, here are air valves the industry has long needed and wanted.

They are tops for performance—operating at speeds equal to any known usage—with shorter stroke, direct operation and a highly efficient *circular* air flow.

Also they operate on the *low current requirements of minimum amplified circuits*—needing just .8 amperes of inrush current.

The valves are compact, too. They are about one-half the size of similar-use competitive valves (½" to 1¼") . . . sell at about half the price in single-solenoid models. You save even more in the double-solenoid models.

There are other savings. Fewer parts and simple design reduce maintenance. Integral conduit boxes connected by wiring duct permit optional wiring. Plug-in lead connectors speed up installation. The MACsolenoid—which operates up to *30 million cycles* without appreciable wear—shaves replacement costs to a minimum.

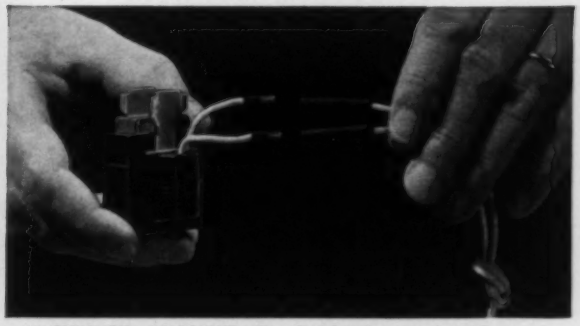
Check the other advantages at the right. Then contact a MAC representative or write direct for all details. The 4-Way Dual-Spool air valves are now available in ½", ¾", 1" and 1¼" pipe sizes. They are quality built throughout . . . meet or exceed *all* J.I.C. standards . . . are fully tested and guaranteed.

Pat. applied for on all valve features ©MAC

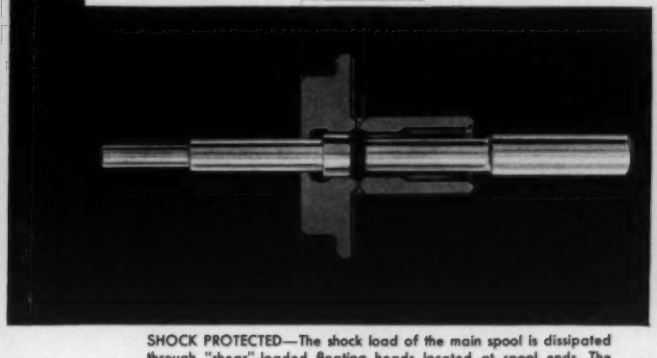
SPOOL

CIRCULAR-FLOW AIR VALVE

SPLIT-SECOND OPERATION—In MAC's exclusive Dual-Spool design, the inner spool operates through the core of the larger outer spool. The MACsolenoid energizes the inner spool, releasing compressed air to activate the outer spool. There is no lag between movement of either spool. Fast, sure operation is assured.



MACSOLENOID CONTROLLED—The Dual-Spool's proved MAC-solenoid has new waterproof plug-in wire lead connectors that are not rigid-mounted . . . thus are vibration-proof. The solenoid and cover assembly detach in seconds without tools. Valve is electrically inoperative with the cover off. Tests at better than 600 cycles per minute.



SHOCK PROTECTED—The shock load of the main spool is dissipated through "shear"-loaded floating heads located at spool ends. The rubber cushions soften the impact, lengthen valve life.

CIRCULAR AIR FLOW—In above double-image photograph, air space is illustrated: air circulates more freely, unhampered by right-angle turns. Valve provides full air flow throughout rated capacities.

MECHANICAL AIR CONTROLS, INC. MAC

10030 Capital, Oak Park, Detroit 37, Michigan

GET THE FACTS FROM YOUR NEAREST "MAC" REPRESENTATIVE.

ARKANSAS
Branch-Merwin Tool Specialists, 477 N. Bellevue, Memphis 5, Tenn., BRoadway 8-6102

CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221

SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., LOrain 4-2521

FLORIDA
MIAMI SPRINGS—Aero Hardware & Supply Inc., 4301 Northwest 36th St., TUxedo 8-2414

ILLINOIS AND IOWA
CHICAGO 6—Walter Norris Engineering Co., Civic Opera Bldg., 20 N. Wacker Dr., STate 2-2804

INDIANA
EVANSVILLE 14—Neff Engineering Co., 2509 Washington Ave., GReenleaf 7-4141

FORT WAYNE 3—Neff Engineering Co., Station A, P.O. Box 2001, 2339 Crescent Ave., EAstbrook 7391

INDIANAPOLIS 2—Neff Engineering Co., 1955 Central Ave., WAlnut 5-5311

SOUTH BEND—Neff Engineering Co., 707 South Eddy St., ATlantic 7-5655

MARYLAND (and Dist. of Columbia)
BALTIMORE 18—N. B. Cochrane Co., 100 E. 20th St., HOpkins 7-4884

MASSACHUSETTS (and New England)
BOSTON 34—Electrical Apparatus Co., Inc., 1200 Soldiers Field Rd., STadium 2-7440

MICHIGAN
BAY CITY—Fred Kober, 506 So. Chilson St., TWinbrook 2-2629

FLINT 2—Kober Sales Engineering Co., 1115 Root St., CEdar 2-7165

WESTERN MICHIGAN—Everett Adams, 17212 Sharon Road, Chesaning, Michigan, VIctor 5-3446

MINNESOTA
MINNEAPOLIS 8—Air & Hydraulic Equipment Co., 15 E. 38th St., TAylor 3-6118

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ST. LOUIS COUNTY—Oscar E. Jost Co., P.O. Box 6, St. Ann, HArrison 8-4488

NEW JERSEY
(NORTHERN) Machinery & Machine Supplies Co., Inc., 305 East 47th St., New York 17, New York, PLaza 8-0744
(SOUTHERN) Automation Aides, 1618 Willow Ave., Philadelphia 26, LaMott, Pennsylvania, MEirose 5-5555

NEW YORK
BUFFALO 26—C. H. Tepas Co., 137 Lamarck Drive, Circle 3210
NEW YORK 17—Machinery & Machine Supplies Co., Inc., 305 East 47th Street, PLaza 8-0744

OHIO
CINCINNATI 2—Fluid Power Engineering Co., 205 Keith Bldg., MAin 1-6640
CLEVELAND 9 (PARMA)—Fluid Power Engineering Co., 5451 Broadview Rd., Florida 1-1199

OREGON
PORTLAND—The Rucker Co., 911 N. W. Hoyt St., CApitol 3-0205

PENNSYLVANIA
PHILADELPHIA 26, LaMOTT—Automation Aides, 1618 Willow Ave., MEirose 5-5555
PITTSBURGH—Machinery & Machine Supplies Co., Inc., 1307 Rutherford St., LEhigh 1-1235

TENNESSEE
MEMPHIS 5—Branch-Merwin Tool Specialists, 477 N. Bellevue, BRoadway 8-6102

TEXAS
DALLAS 35—Womack Machine Supply Co., 2010 Shea Road, FLeetwood 7-3871

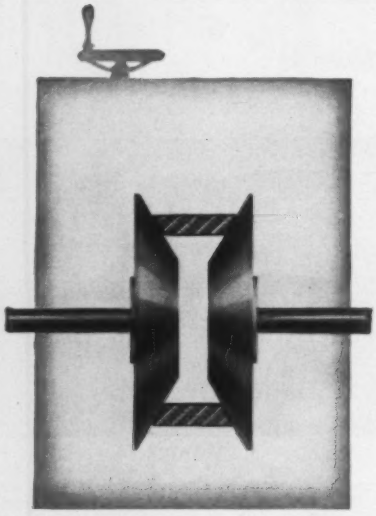
WASHINGTON
SEATTLE—The Rucker Co., 1000 4th Ave., South, MAin 2783

WISCONSIN
MILWAUKEE 17—Neff Engineering Co., 5856 No. Pt. Washington Rd., EDgewood 2-1579

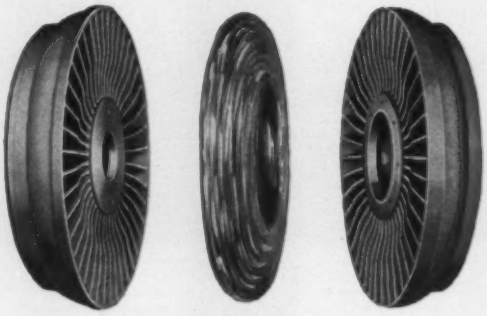
CANADA
MONTREAL—L. S. Tarshis & Sons, Ltd., 450 McGill St., Quebec, PLateau 2963
TORONTO—Trevor Babbs, National Time & Signal Co., 72 Shilton Rd., Agincourt, Ontario, OXford 1-4857

Circle 679 on Page 163

Now! See why American Blower *Gýrol*® Fluid Drive is your best adjustable-speed investment!



Comparison proves: Gýrol Fluid Drive protects against shock *far better* than friction-type drives; gives *more accurate* speed control; reduces maintenance!



FRICTION-TYPE DRIVE

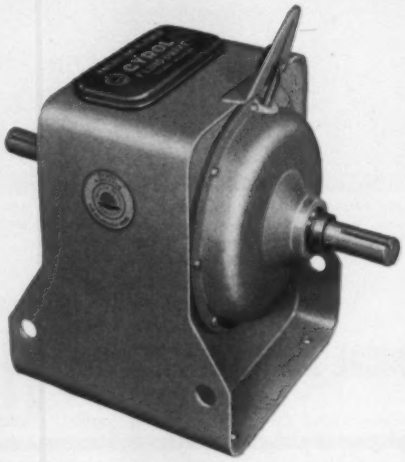
Friction-type drive is subject to heat, wear, and tension. Mechanical connection transmits shocks. Speed control varies with wear.

GÝROL FLUID DRIVE

Vortex of oil isolates shock. Stepless, adjustable speed is controlled by a simple, wear-free speed controller.

Compare—then *specify* Gýrol Fluid Drive

FEATURE	GÝROL FLUID DRIVE Type VS Class 2	FRICTION-TYPE DRIVE
1. Shock protection	Vortex of oil isolates shocks.	Mechanical connection transmits shocks.
2. Maintenance record	Good—few wearing parts; extra-long service life.	Poor—multiple wearing parts; power transmitted by friction.
3. Accuracy	Simple, wear-free speed control.	Wear and tension affect control.
4. Service limit	Unlimited—all Gýrol Fluid Drive ratings are for continuous service.	Limited—service factors influence selections.
5. Horsepower rating	Units available up to 800 hp.	Units available to 100 hp.



Type VS Class 2 Gýrol Fluid Drives, compact and self-contained, come in sizes from 1 to 800 hp. Other classes handle up to 12,000 hp. Get full information today! Contact one of our 73 branch offices, or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

* American-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard

AMERICAN BLOWER DIVISION

Circle 680 on Page 163

By JAMES C. KEEBLER
Managing Editor

Joanne Powers of General Motors Research Staff lights a cigarette as this 1958 Chevrolet moves along with "no hands." This "breadboard" equipment is testing the idea of electromagnetic vehicle guidance. System uses combined electronic computer and servosystem to take over steering control and follow a magnetic path produced by low frequency current in a cable beneath the concrete surface

On The Road Ahead

"ELEVATED superhighways with monorails suspended beneath them may carry intercity motorists and train commuters in the year 2000 on a single rifle-straight 'transportation core in the sky.'" This suggestion is made by General Motors and illustrated by an operating model in a GM exhibit at the Brussels Universal and International Exhibition.

Dreamboat?

This is a trilevel vision. The top two levels are three-lane, electronically controlled highways, each carrying vehicle traffic in one direction. Beneath the lower highway is suspended a two-way monorail train system.

The dream continues: "The entire trilevel 'core' is set like ladder steps between pairs of pillars which vary in height with the terrain to keep the 'core' straight. Eliminating curves and hills which are still present in most of today's modern superhighways, the 'core' would carry passengers 'as the crow flies,' fording rivers and urban areas and tunneling through mountains where necessary."

Dreams Come True

The long, long trail that's straight (not a-winding) into the land of these dreams must be viewed as a potent potential that may be a reality after the long, long night of waiting. After all, at the New York World's Fair of 1939, GM presented, in its "Futurama" exhibit, a highway forecast which accurately prophesied the limited access superhighway systems which are being built today.

The trilevel highway would be ultrasafe because all vehicles would be under complete electronic guidance, an advanced form of the rigging that's already running at the GM Tech. Center.

The test track has a wire in the concrete. There's a low frequency alternating current in the wire, creating a magnetic field around the wire. The snooping is done by a pair of tuned pickup coils that are mounted on the front bumper of the car. The coils straddle the wire. Voltage present at the terminals of the coils depends upon strength of the magnetic field. If this slave auto moves away from the wire there will be a difference in voltage from one pickup coil to the other.

This voltage difference is an input signal to an analog computer on the dashboard. The computer controls a servosystem that's hooked to a modified power steering unit. Net result: automated driving.

Such a system releases the driver to do other useful work while cruising along. Need a fourth for bridge or a gin rummy partner! The lady in the photo is lighting a cigarette. Most women drivers are accused of this sort of activity behind the wheel even without the benefit of electronic guidance. It's the hand of Providence that keeps them alive.

Lawrence Hafstad, the VP in charge of GM Research Staff says that this breadboard job is the hardware phase of a system demonstrated in model form in 1953 by Radio Corp. of America. Meanwhile RCA had set up a test strip near Lincoln, Neb., with the road equipment for a signal system. The GM control is looked on as the first building block in a more sophisticated system for controlling vehicle spacing, detecting location of cars, and providing signals for throttle and brake control. These functions would be necessary for the performance level required in the core-in-the-sky approach.

By dreaming dreams, by participation in the Automobile Manufacturers' Association Highway Policy Committee and in activities of the Institute of Traffic Engineers, the automakers acknowledge that there's more to this business than just making wheeled vehicles to go down the road. Design and

building of the road ahead is important too. The automotive engineer, highway engineer, and traffic engineer are all in the act and must all co-operate.

Who Knows?

Though the road ahead may have many imponderables—like whether or not there will be cores-in-the-sky or whether or not the Big Three will come out with small cars and get back into the low-price class—there's one thing that's sure as the national debt and that's the road building job ahead.

The government in Washington has committed a pile of jack to the task and the 48 states are writing contracts faster than Reuther is. This gives the automaker another phase of the transportation business to grow with—the manufacture of road-building equipment.

This too is a big business in more ways than one. Not only are road-building machines needed in increasing quantity but the components of the equipment take on such substantial proportions that they are properly described by the word *big*.

An interesting line of automatic cycling machine tools has been built by W. F. & John Barnes Co. to machine road-building equipment components. One of the principles of machinery arrangement used on four of these machine tools is that of a rotary index machine in reverse. Instead of indexing the workpieces around to the various cutter heads, as is customary on rotary indexing transfer machines, the workpiece is fastened to a slide and the cutter heads are mounted on the stations of the rotary table.

Working Arrangement

Operation of equipment of this layout involves an *In* and *Out* motion of the fixture slide alternately with an indexing motion of the table. Each time the slide approaches the table it presents the workpiece to a different set of cutting tools. This has some aspects of a turret lathe only it's not spinning the work, it's spinning the tools, and the tools are in multiple heads so that as many tools are working simultaneously as is feasible.

Variations on this theme of bringing the mountain to Mohammed include: 1. Two work slides attached to one rotary table. 2. Two rotary tables on opposite ends of one work slide. This latter arrangement is illustrated herewith.

This is a big machine. Fixture saddle is mounted on 40-inch ways. Five-station rotary tables are each 96 inches in diameter. Approximate weight of each table equipped with heads, motors, spindles, and bushing plates is 40 tons.

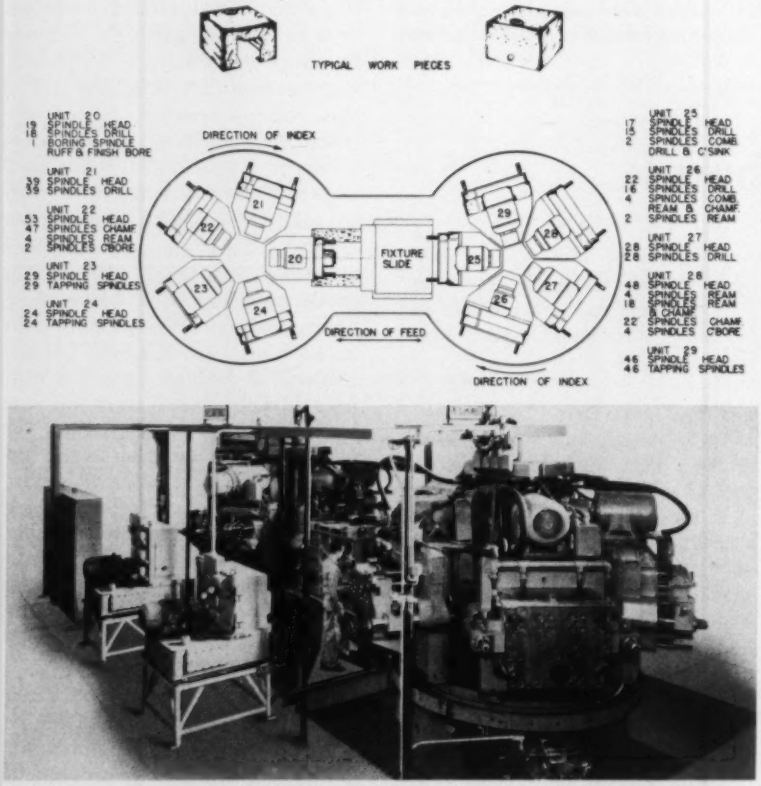
Costs of capital equipment and floor space usually run high on machines for large workpieces. As opposed to doing this work in separate machines, the first four machines of this installation are estimated to effect a 50 per cent reduction in equipment costs and an 80 per cent reduction in floor space.

Hydraulic systems for such equipment are simpler because the machines are designed with stationary-type heads (tapping heads are equipped with individual lead screw spindles). The only hydraulic actuation that is required operates the rotary indexing tables and the shuttle-type work holding fixture.

Load Saver

Combining many operations in one machine gives important savings in work-handling time. It takes 3 minutes to load one of these giant workpieces and 2 minutes to unload it. Therefore, the fewer loading and unloading operations in the production sequence, the more handling cost and production flow-time saved.

Whether this type of multispindle equipment will find a place in the production lines of on-the-road vehicles as well as off-the-road vehicles remains to be seen. But on or off, the automakers are very much in the market for new techniques of improving their production processes. Doing things automatically holds great promise on the road ahead for both drivers and the builders.



Automatically cycling machine built by W. F. & John Barnes Co. to drill, ream, chamfer, and tap holes in welded steel cases which are components of road-building equipment. Two rotary index tables have five stations each. Fixture is shuttled back and forth between tables which bring each set of tools in turn into work position

FARVAL—*Studies in Centralized Lubrication*
No. 218

Farval lubrication first choice for Hill-Acme Upsetter

On this 1¼-inch Hill-Acme Upsetter, Farval's timing cycle can easily be changed to conform with the service of the macnine. Amount of lubricant delivered to each bearing is also adjustable.

BUILDING peak performance into their machines is a point-of-pride with Hill-Acme. That's why you'll find Farval lubrication systems on H-A machines such as this upsetter.

When the going's rugged, with shock, vibration and wear trying to take their toll, Farval continuously guards 59 vital bearings . . . continuously delivers measured amounts of lubricant at regular intervals.

More and more, machine designers, engineers and production men are turning to Farval for the kind of lubrication that spells uninterrupted, maintenance-free production. Let us tell you more. Write for Bulletin 26-S. The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

KEYS TO ADEQUATE LUBRICATION

Wherever you see the sign of Farval—familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

Circle 681 on Page 163

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The *FORWARD* Look develops...

AUTOMATIC CAR-A-MINUTE ASSEMBLY WITH WESTINGHOUSE DRIVES AND CONTROL

This man helps direct a 1960-new control system engineered by Chrysler Corporation and Westinghouse for unique material-handling methods. Utilizing more electrical power and exacting control, Westinghouse designed this system to automatically synchronize the flow and positioning of parts for assembly along 51 conveyor lines. Here is a system, too, that minimizes unscheduled plant down time and many maintenance headaches.

On the next five pages you'll see how Chrysler is perfecting "tomorrow's" assembly . . . today. Here are head-start ideas you can use, if you begin now to POWER-UP electrically.

MP-3058

YOU CAN BE SURE...IF IT'S Westinghouse

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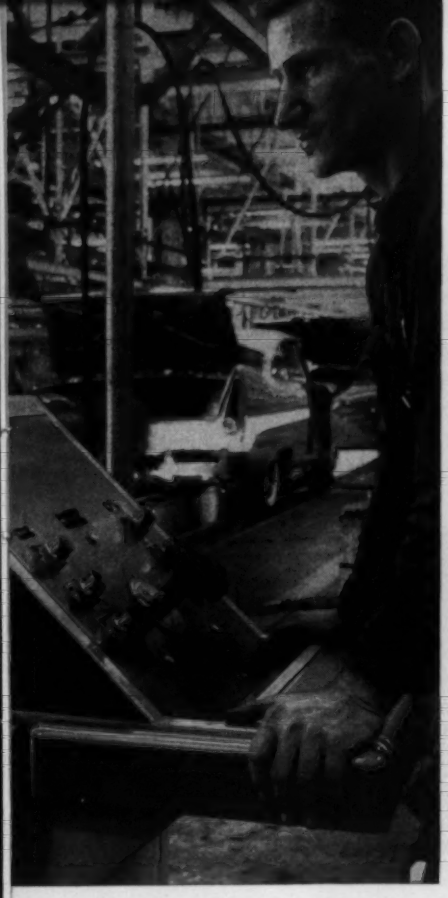
How do ivory fenders reach the ivory body shell on time and in position?

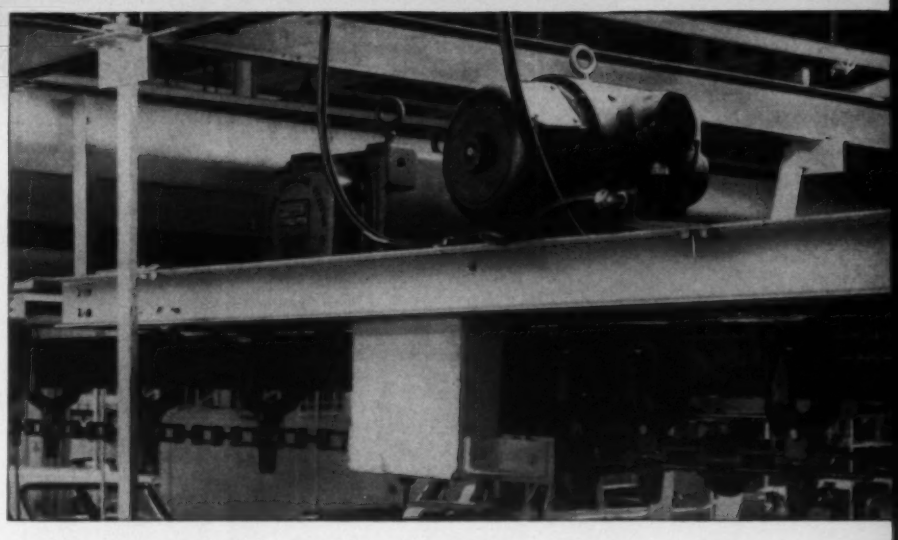
MAGAMP-CONTROLLED AV DRIVES INSURE EXACT MATCH-UP OF BODY PARTS

In this Plymouth assembly plant, two and one-half miles of floor conveyor and over five miles of monorail conveyor are synchronized to travel in unison. Transfer from one conveyor to another is completely automatic at hundreds of transfer points. For example, front fenders (above) travel to the right and left side of the body assembly conveyor, arriving at the assembly point exactly in step with a body shell of the same color.



▲ *Fully automatic, Magamp speed and position control can be operated manually if desired. Magamp is most ideally suited to automatic operation as it is a highly reliable static device requiring no maintenance and no warm-up time.*

▼ *Conveyor AV Drive components are factory-assembled in free-standing cabinets centrally located in each plant zone.*



Westinghouse Life-Line® Motors ▶ *are located on conveyor supports or below the floor for conveyor drives. Prelubricated bearings and rugged insulation protection require minimum maintenance.*

Westinghouse AV Drives provide the complete, adjustable voltage d-c drive and regulator system to power up and synchronize all conveyors. A synchro-tie transmitter on the lead conveyor, or an independently driven transmitter, is used as a master reference for all slave conveyor sections. The transmitter on each slave conveyor is used to signal exact conveyor position. A Magamp* regulator compares the master and slave synchro-tie signal and makes any necessary correction to hold each slave conveyor in step with the master.

Exact control of the line speed is possible by means of incremental speed adjustment of the master synchro-tie transmitter. On multi-motor conveyor section drives, correct load sharing between motors is insured by proper machine and control coordination.

*Trade-Mark

Next page—Static control memory helps schedule assembly.

YOU CAN BE SURE...IF IT'S **Westinghouse**

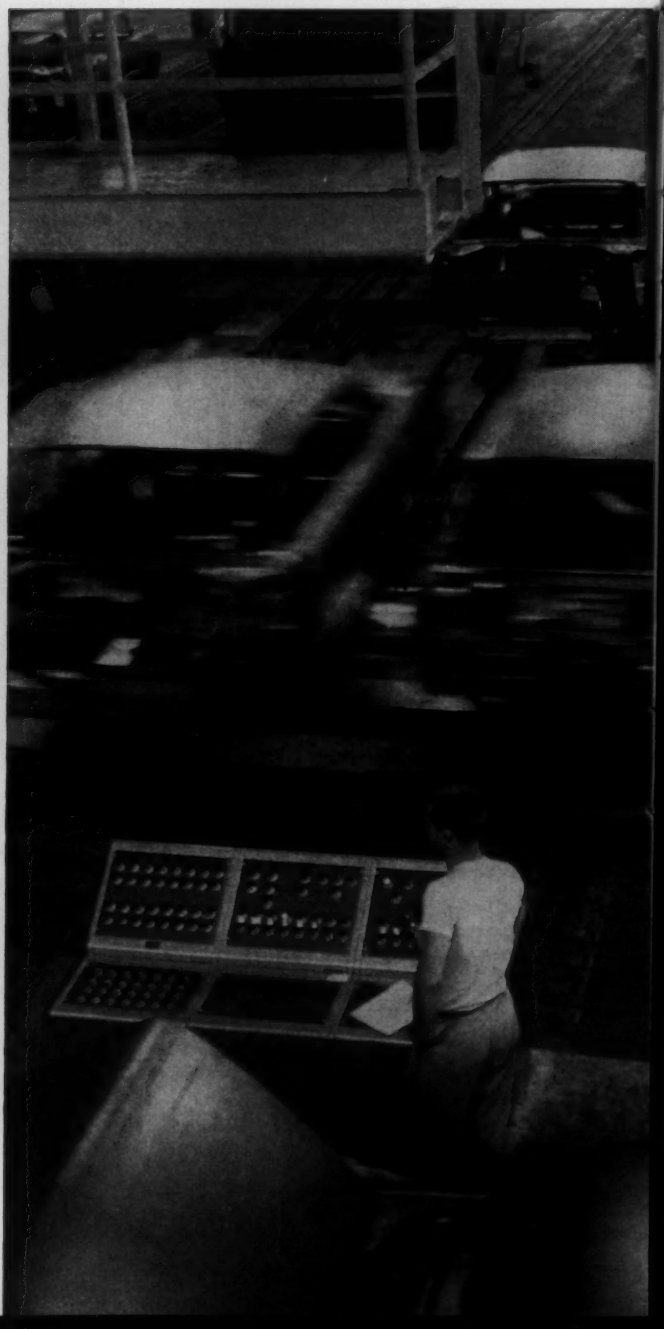
Circle 683 on Page 163

How is each body shell picked out of hundreds and prescheduled for color styling?

CYPAK CONTROLS
PUSHBUTTON SORTING, STORING AND TRANSFERRING

Modern assembly means no manual handling at the Plymouth plant in Newark, Delaware. Example—Cypak* control systems provide pushbutton handling for each body shell as it is stored and transferred through this 15-conveyor-line

*Trade-Mark



storage bank. Cypak takes full responsibility for storage and for removing each auto body in preselected order to meet paint shop scheduling.

The operator at the console (below left) selects a storage line for each auto body by pressing a pushbutton. This initiates an indexing cycle which automatically follows through at all transfer points. At the other end of the storage line (below center) an operator selects the proper production mix of body style. Cypak automatically indexes the body shells through each transfer point to the main conveyor.

Cypak static control was selected for this memory storage system because it is completely maintenance-free. System reliability is extremely high.

Next page—Control planning simplifies trouble shooting.

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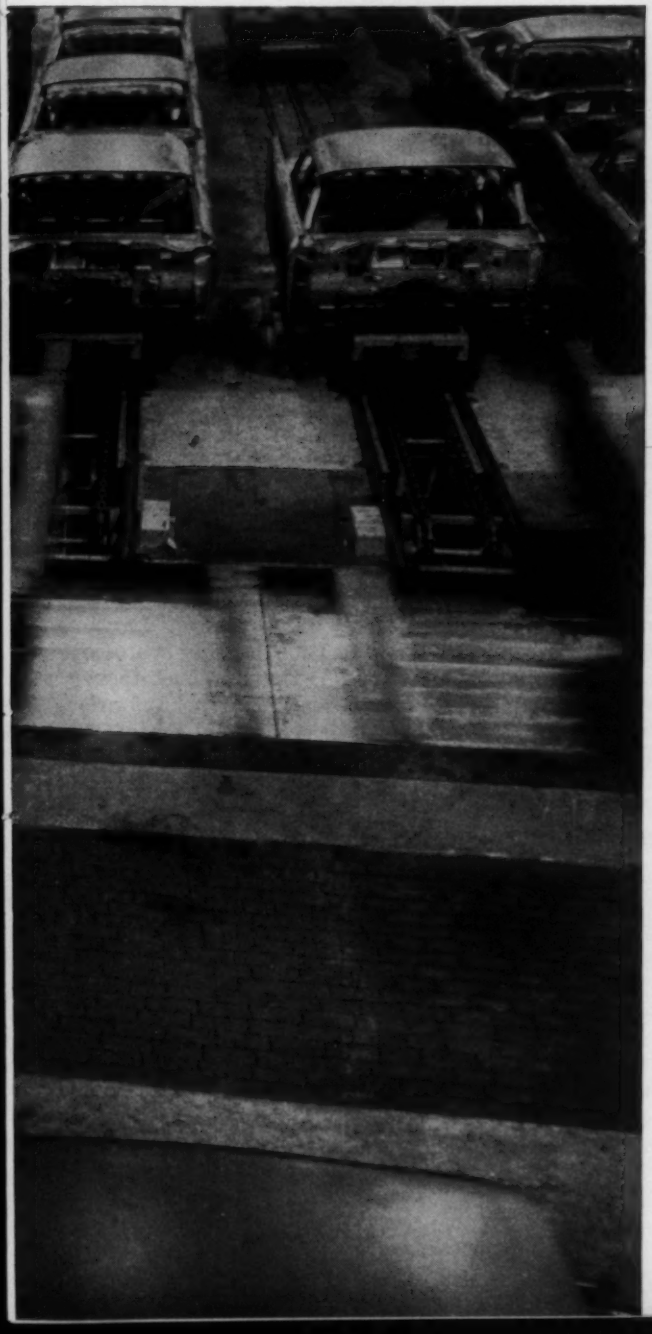

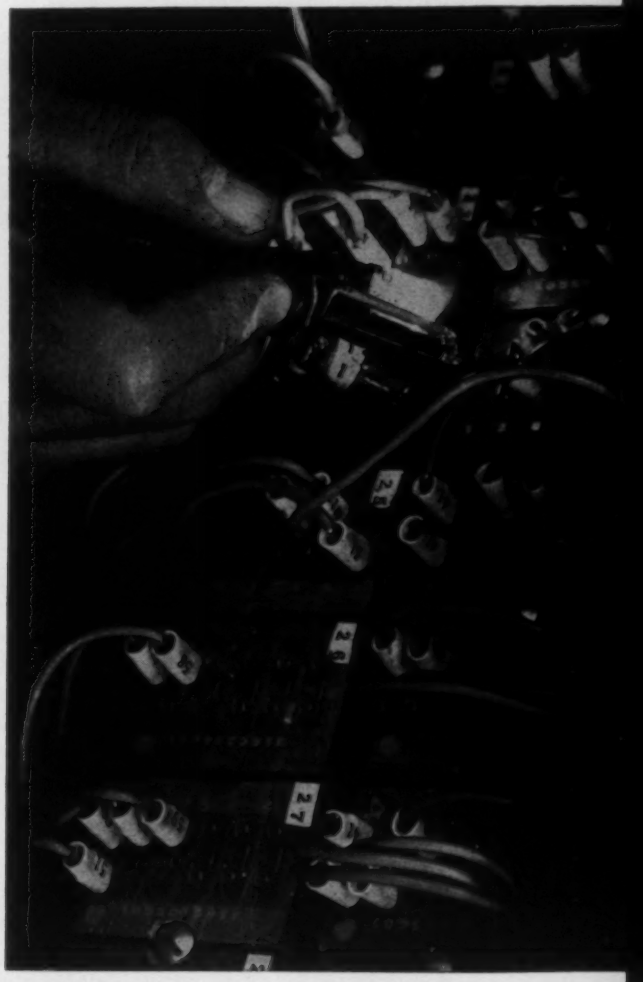

Cypak control elements are plugged into power channel busway to form compact system assembly for easy inspection. Wiring system diagram designates proper connections for tab connectors between top terminals.

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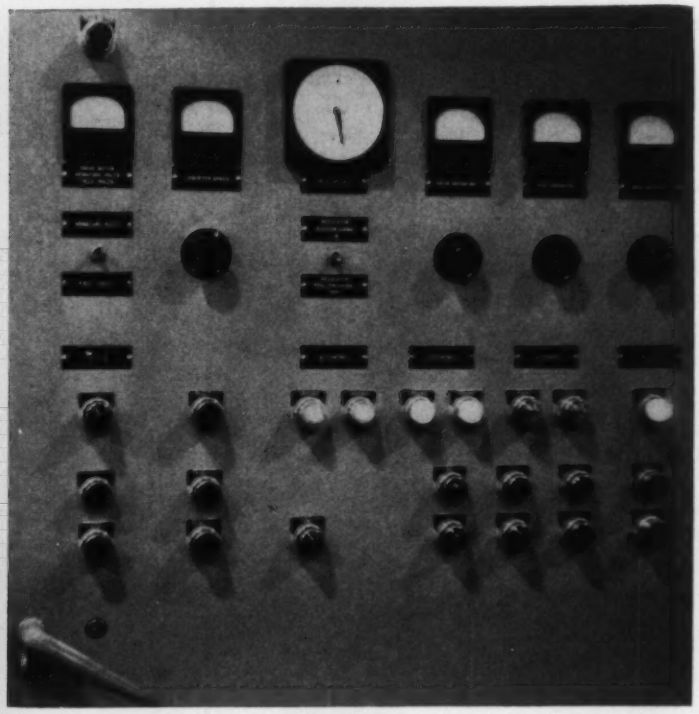
How does electrical planning limit down time?

COORDINATED CONTROL AUTOMATICALLY TAKES RESPONSIBILITY



. . . to simplify trouble shooting

Unscheduled down time is minimized because of careful planning between Chrysler and Westinghouse engineers. Trouble locations are pinpointed by signals on panel-front diagrams (above left) of conveyor lines. A panel-front synchroscope (above right) is located on each AV Drive cabinet to keep electricians accurately informed of conveyor synchronization.

Checks on the position-regulating system are made automatically. If a position error above tolerance occurs, the conveyor will stop and postpone transfer until it is safe.

. . . during shutdown and start-up

Cascade-type electrical interlocking prevents pile-ups wherever a series of conveyors are running together. Any stop on one conveyor will stop all conveyors feeding into it. After the first conveyor is restarted, the others will automatically restart. The responsibility for starting and stopping conveyors is built in through advanced electrical planning.

If your production plans call for forward-looking material-handling drives and control, call your local Westinghouse sales engineer for expert counsel and experience, or write Westinghouse Electric Corporation, 3 Gateway Center, Box 868, Pittsburgh 30, Pennsylvania.

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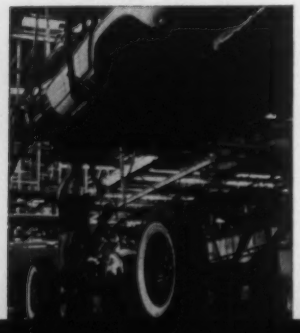


Circle 683 on Page 163

The New Trend

As automation has come of age some subtle changes have taken place in industrial practices. Of key importance among these changes is the new approach to the engineering of productive operations.

Today, unlike past practice, there is singular concern given the problem of precisely how a product is to be processed. The basic and necessary steps required to create profitably the desired end product have equal importance with product design itself. This key position of manufacturing engineering is strongly reflected in the greatly expanded programs of industrial research in this field.

Noteworthy attainments have emphasized the importance of careful analysis of the processing system prior to development of suitable equipment. As a result, the engineered production system is the modern trend. Manufacturing engineering has taken its place as a vital segment of the industrial enterprise.

In no small way, automation has been the catalyst in this reaction. Haphazard approach to conventional production operations seldom created a serious cost problem in past years. Experience with automated operations, however, has led to the need for careful development of the entire system into an organic whole. Unless the entire approach is carefully engineered, automation can be a flop. But, it has been found that this engineered approach to manufacture pays off regardless of the level of production contemplated.

To develop really efficient production systems, calls for broad new thinking. Outmoded company practices such as the questionable policies of buying "pounds of machinery" or justifying machinery on the basis of operators eliminated, must be replaced by an open-minded attack on production problems. Results can be well worth the effort.

One production operation, on which five years and a quarter-million dollars were spent unsuccessfully, was put into effective service for only five thousand dollars and a few months engineering. In another instance, a line of products carefully re-engineered by automation specialists created substantial savings with only minor upgrading of conventional equipment.

The answer primarily lies in the fundamental approach to creative design of the production system itself.

Automation manufacturing engineers have a key role to play in our industrial future. Regardless of the character of the operations to be performed, an automation engineering approach will provide the answer to more profitable operations.

EDITOR

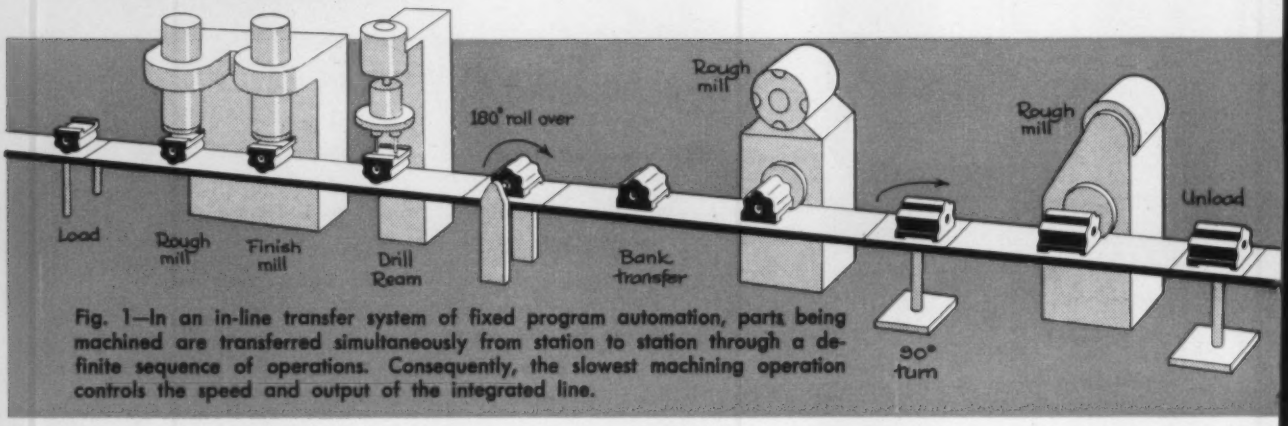


Fig. 1—In an in-line transfer system of fixed program automation, parts being machined are transferred simultaneously from station to station through a definite sequence of operations. Consequently, the slowest machining operation controls the speed and output of the integrated line.

BASIC CONCEPTS IN SELECTING

INTEGRATED MACHINE TOOL SYSTEMS

Creation and production of individual automatic machining units has long been the backbone of the machine tool industry. Today, the industry is concentrating its talents on combining these highly automatic units into "packaged" production systems. The basic concepts entering into the design of packaged systems should prove valuable reading to potential users of these systems.

By W. F. JESSUP
Supervisor, Automation Section, Engineering Service Dept., Cincinnati Milling Machine Co., Cincinnati, Ohio

MILLIONS of words have been written about the word automation over the past few years and its meaning has gradually started to take a recognizable shape. Those who stand to gain the most value from its use are now seeking the ways and means of putting its principles to work for them.

Since automation is most often used in large manufacturing plants, it is in these plants that "future planning" groups are most active. These groups are comprised of people who are very interested in the direction and development of automatic techniques and philosophies. Fortunately for them, the manufacturers of metalworking equipment are in the midst of a minor revolution in their attitude toward their role as suppliers of both equipment and know-how to industry. Since they have made great strides in developing individual manufacturing units which will perform almost every conceivable task automatically, they have now turned their talents for creating production hardware to the job of creating integrated "packaged" automation systems which will provide their customers with highly automated systems that have been engineered, tested, and debugged on the vendor's floor. An advantage of this package approach lies in uniformity of concept which can be maintained through-

Fig. 2—Typical Cincinnati in-line transfer system is used to mill, drill, and ream automotive transmission cases. This system of integration is commonly called "Detroit type" of automation and is one of the oldest types of fully automated machine tool systems.

out the entire system where all of the design work for the machining, handling, and control elements are conceived by one central group.

Since the machine tool builders are asked to provide automated systems for producing parts in all segments of the metalworking industry, there is certain to be a wide diversity of types of equipment to be integrated into the various systems. Consequently, their first responsibility has been to formulate basic systems concepts which are universally applicable. In this search for basic concepts, two types of fully automated machine tool systems have emerged: The "selectable program" type and the "fixed program" type.

Program Types

The selectable program type of machine tool automation is commonly known as the "numerically controlled" system. Equipment used in this system is currently in a very advanced state of development, but up to the present time is rather limited in application. Most applications are on individual machines, and integration of such units into completely automated systems remains a problem for the future.

Fixed program type of automation is designed to perform a specific operation or a series of operations on an individual part or group of similar parts. In this system of automation, both the machining of parts and their transfer from station to station are automatic, and this system is commonly called "Detroit type" of automation. In a multitude of applications in high production industries throughout the world, fixed program type of automation has

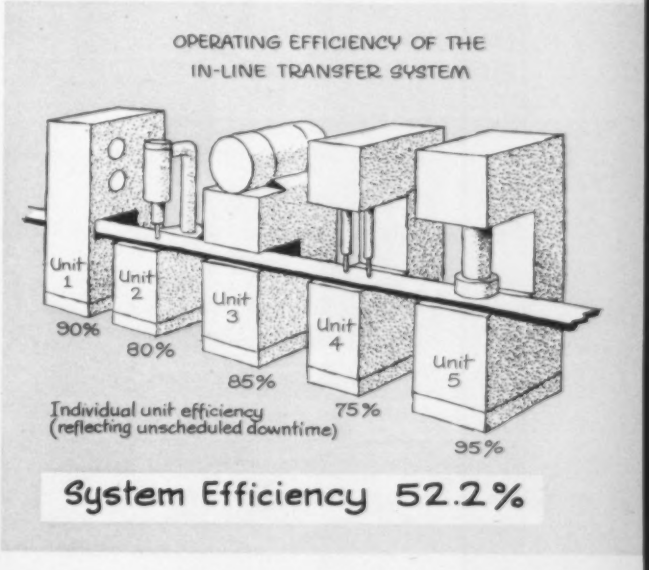
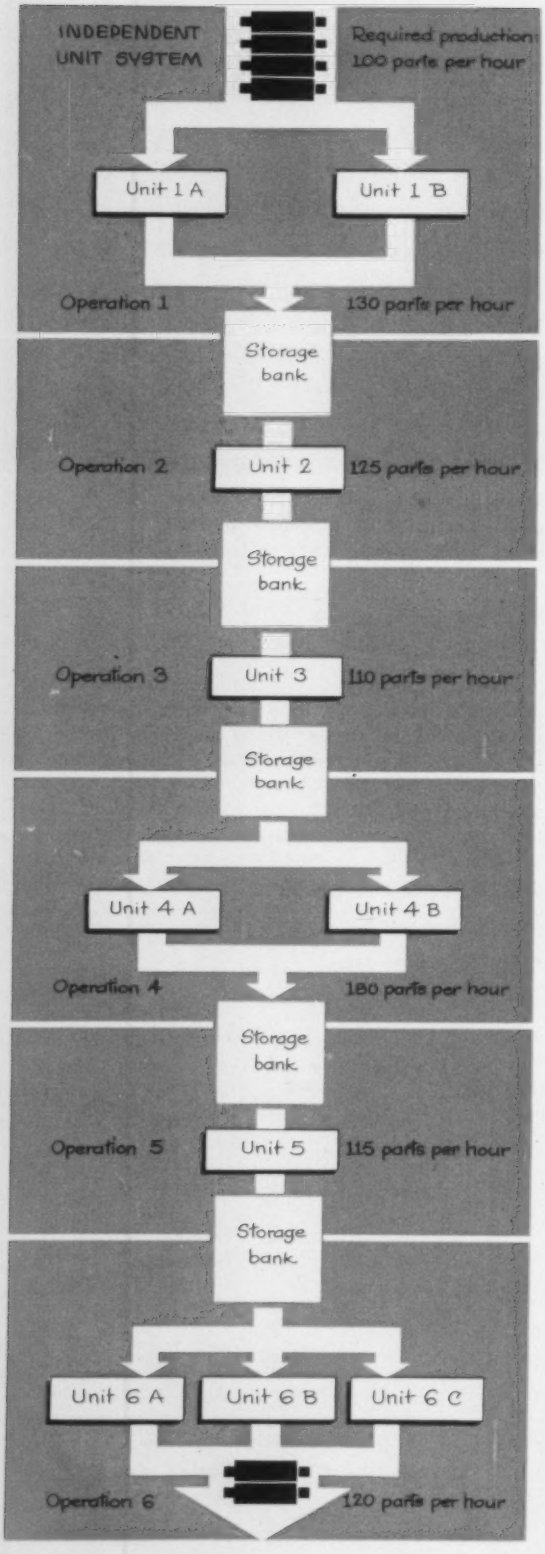


Fig. 3—The system efficiency of an in-line transfer system is considerably less than the individual efficiency of any one of its components. This is due to all units being forced to stop producing when any one unit in the system is down.



proved the feasibility of the principles of automation. There are two subdivisions within fixed program automation: The in-line transfer system and the independent unit system. In some cases both systems are composed of units of special design; in other instances, particularly in independent unit systems, standard machines equipped with special tooling are used.

In-line Transfer System

In the in-line transfer system of fixed program automation, parts are fed through a definite sequence of in-line operations, *Fig.* 1 and 2. The system is set up in units, and all parts in process within a unit, or group of units, are transferred simultaneously. Consequently, all parts must await the completion of the slowest operation before starting a new transfer cycle. This is the oldest type of completely automated machine tool system, and it was orginally developed as the natural evolution towards providing mechanical means of handling parts which, by their size and weight, fell outside the range of being handled expeditiously by human hands.

One of the most serious disadvantages of this type of system is that the inherent inefficiencies of individual machining units are compounded as they are tied together by a single parts transferring device, *Fig.* 3. Its most important advantage lies in its ability to maintain a three axis orientation very accurately throughout the entire sequence of operations. Over the years, since the inception of the idea of transfer type automation, the trend has evolved toward less and less machining units per single transfer unit and increasing use of automatic banking between groups of units. In order to arrive at maximum efficiency, this type of system may well evolve into a system made up of individual units, with the transfer of the part from unit to unit also performing the function of storage banking.

Independent Unit System

Another type of fixed program automation is the independent unit system which is set up so that each machine can cycle at its maximum rate. This system can be arranged for either straight-line flow of parts or for parallel flow of parts to the various units of the system. In either method, the machine cycling rate is limited only by the requirements of the machine operation and by the speed of the load-

Fig. 4—In an independent unit system of automation, storage banks located between each operation allow each unit in the system to operate independently. Tool changes, adjustments, and maintenance of individual units will not affect the production of the system until banks downstream from the unit are empty.

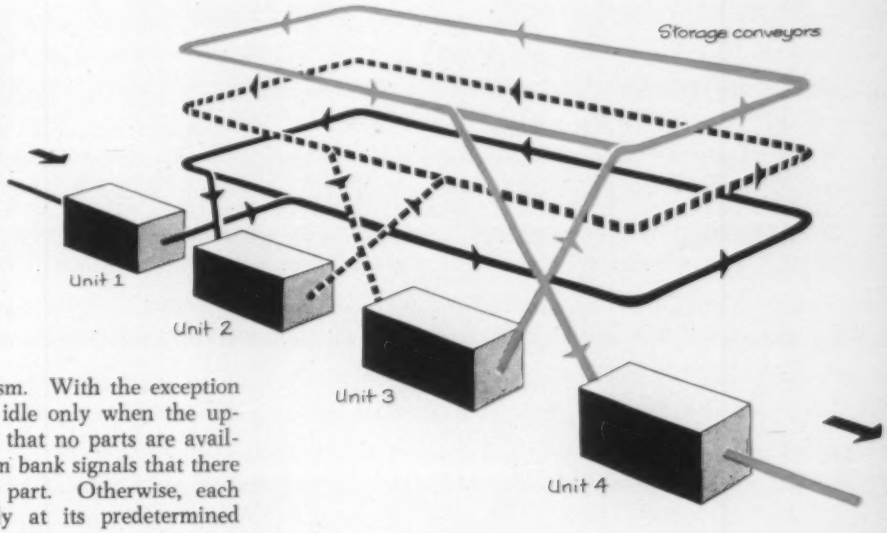


Fig. 5—Another type of parts storage used with the independent unit system of automation is the multiple conveyor system known as parallel flow of parts. Each deck of the conveyor system is a continuous loop which receives parts from one machining unit and stores them until the next machining unit requires parts.

ing and unloading mechanism. With the exception of downtime, a machine is idle only when the upstream banking unit signals that no parts are available or when the downstream bank signals that there is no space for a finished part. Otherwise, each machine cycles continuously at its predetermined cycling rate.

Straight-line flow of parts in an independent unit system is shown in *Fig.* 4. Required production for this particular system is 100 parts per hour. Since one unit in the first operation would produce only 65 parts per hour, another unit was added to make a maximum capacity of 130 parts per hour for this operation. In the second operation a single unit making 125 parts per hour is sufficient to meet the required production. The same holds true for the third operation which has a capacity of making 110 parts per hour. The fourth operation requires two units—each making 90 parts per hour for a total production of 180 parts. The fifth operation requires one unit cycling at 115 parts per hour, and the sixth operation uses three units of 40 parts each for a total output of 120 parts.

Since the third operation at 110 parts per hour is the slowest, it will run fairly continuously while the other operations cycle intermittently. In this case it might seem reasonable to cycle all machines at the rate of the third operation. However, if adequate banking capacity is available for the third operation, it can continue to run during the downtime of any of the other units in the system with only a loss in bank capacity resulting from the stoppage. Then, when these units are again in operation, the excess in production capacity over the system rate—which all operations other than the third are capable of—will re-establish the original status of the bank capacity. This method of operation adds to the system flexibility and allows the slowest operation to maintain continuous production as much as possible.

To keep an independent unit system operating properly, a parts bank is necessary between each operation. These banks serve two purposes. 1. They equalize the flow between operations having varying cycling rates. 2. Provide a place for the storage of parts so that the line continues to operate even though one or more units are temporarily nonproductive due to tool changes, adjustments, or maintenance. When all units are operating, banks preceding the slowest operation will be full at all times. The banks following the slowest operation will be empty except for parts in transit downstream. Since the third operation in the illustrated example is the slowest in the system, its production controls the rate at which finished parts are produced by the entire system. Consequently, the system as a whole must be provided with sufficient banking capacity so that the third operation will never be slowed down by a lack of parts to be machined or a lack of space in which to bank machined parts. A popular idea concerning banks in an integrated system of this kind is that they are parts storage units, and as such, it is desirable to maintain them full. In actual operation it has been found that "space available" to receive parts from an upstream unit during downtime of succeeding units is just as important as "parts available" for a downstream operation insofar as the actual capacity of the bank is concerned.

Another type of flow used in an independent unit system is shown in *Fig.* 5. This is known as parallel flow of parts and consists of individual machining units being fed by stacked banks in a multiple conveyor system. Each conveyor bank is in the form of a continuously running loop. The loops are mounted one above the other and run parallel to the line of machines they serve. The first machine in this system is fed parts from an area outside the system. After being machined in the first unit, the parts are transported into the lower conveyor loop where they are stored until the second unit requires parts. The cycle continues with parts being taken from the lower conveyor loop into the second unit and then transported into the middle storage loop; from the middle storage loop into the third unit and back to the upper storage loop; from the upper storage loop into the fourth unit and from the fourth unit via conveyor to another processing area. In the event a conveyor loop should become filled with parts, all machines preceding this loop will stop until space is again available in this loop. If a conveyor loop becomes empty, all suc-

ceeding machines will stop until parts are available in this loop.

Feedback Controls

Banking, transfer, and loading devices in the independent unit system replace much of the physical effort formerly required on the part of the operator. Feedback controls, so essential to automation in this type of system, take over much of the routine checking and repetitive adjustment of the machine units necessary to maintain constant cycle time and dimensional accuracy. Feedback, or closed loop controls govern one of the most important functions for automated equipment—the function of self-regulation which is one of the features setting fully automated equipment apart from automatic cycle machine tools.

Feedback controls allow the machine to sample the dimensions of the finished part and automatically adjust itself for any deviation from the required specifications. Typical examples of machine units capable of being integrated into an independent unit system are shown in *Fig.* 6, 7, and 8. These machines are equipped with the necessary automatic handling and feedback control features that are so important in an independent unit system.

Monitoring

An important part of any automated system is a central monitoring panel. It serves the very important function of reducing operator attention required by individual units in the system by bringing all pertinent information to a central point and displaying it with signal lights on a control panel. An operator can tell at a glance if there is a malfunction in the system or if a tool is approaching the limits of its anticipated life. In general, tools requiring long change times will operate several shifts or days before requiring replacement and can be replaced during an off shift. Items which must be replaced more than once a shift can usually be changed while the system is using the capacity of the banks affected by the down machine without a production loss from the system.

Included in the monitoring console should be devices capable of accumulating production data from each operation. These data can then be fed directly into a simple digital computer which is a part of the monitoring console or is located in another part of the plant. Such information is valuable to man-

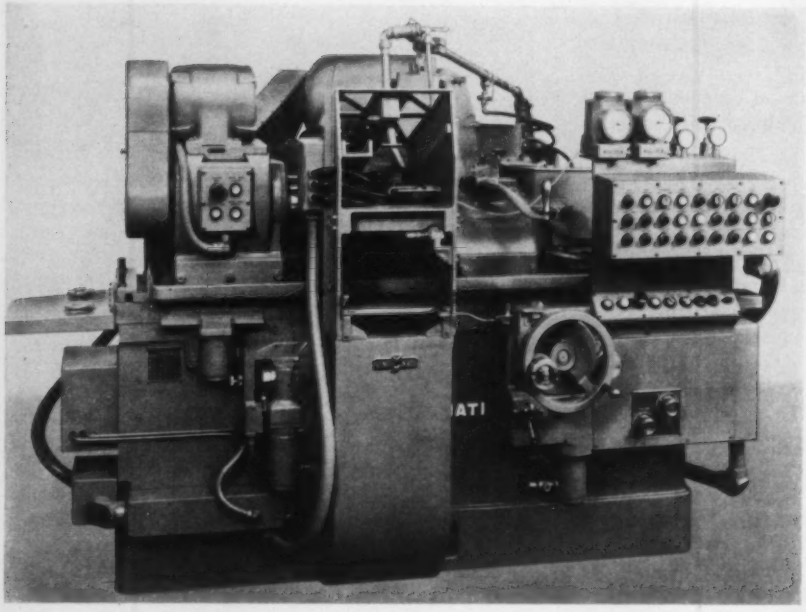


Fig. 6—Fully automated angular grinding machine is an example of a Cincinnati machine that is often used in an independent unit system with parallel flow of parts.

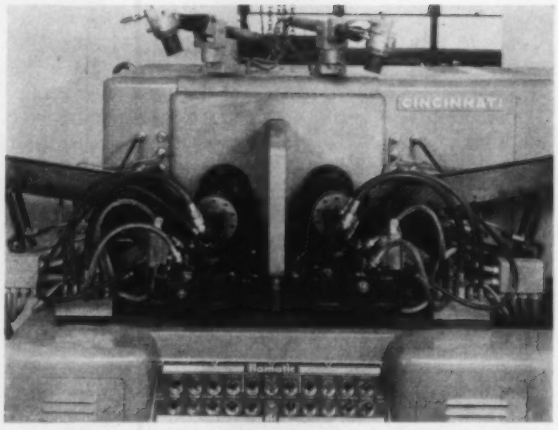


Fig. 7—Equipment such as a Cincinnati Flamatic hardening machine equipped with feedback controls makes it possible to apply the same degree of automation to heat treating as to machining operations.

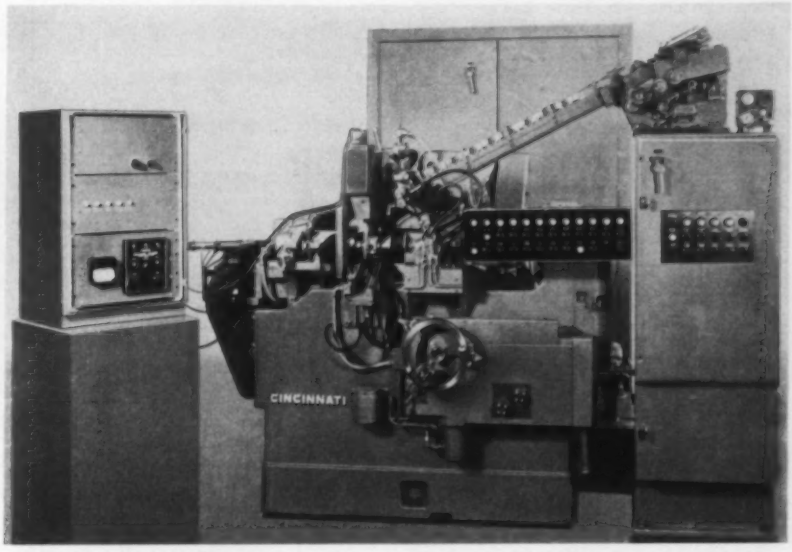


Fig. 8—Feedback controls on a fully automated Cincinnati piston relief grinding machine allow the machine to sample dimensions of finished parts. Corrections are automatically made by the feedback control when required.

agement for use in preparing reliable and accurate cost data.

Summary

One important advantage of the package approach in producing an integrated machine tool system lies in checking the system after it has been built and assembled. Since a standard practice of a machine tool builder is to operate a newly built machine on limited production on his own runoff floor, the same procedure is followed when he supplies a whole system. He then has at his disposal for the runoff the same engineering talent that conceived the original principles and designs, with the result that any isolated changes required on the mechanisms do not compromise the basic systems concept. During the runoff the customer is required to make available those people who will be charged with the responsibility of operating the system. Since they are in attendance during the entire runoff, they will be familiar with every detail of the system's operation. When the system has been accepted by the customer at the completion of the runoff, the entire system can be transferred to the customer's plant and started into almost immediate production.

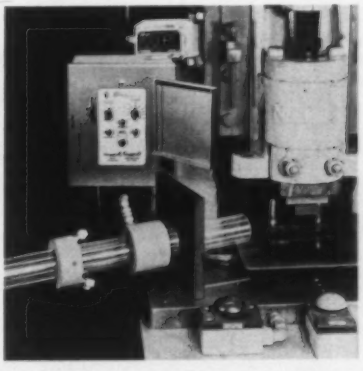
The success of integrated systems that have been designed, built, and installed under this procedure to date indicates that the package approach to providing entire automated systems is a challenge that machine tool builders will be glad to accept from the metalworking industry.

Punch Press Control

ELECTRONIC press control which eliminates "double-heading" of punch presses is manufactured by Robotron Corp. Die breakage and press downtime are held to a minimum by the unique control which stops the press from completing its stroke whenever the stamped piece is not properly ejected from die.

The press control is comprised of two parts—a control panel whose contacts are connected to the press circuit, and a detection unit which consists of a high radio frequency coil mounted on a cast acrylic tube. The acrylic tube is electronically as well as optically transparent.

The detection unit is attached at the die-face, next to the ejection point. As each piece is ejected, a stream of compressed air draws the part through the tube and coil, breaking the radio frequency field, and closing a set of contacts in the control panel.



When a piece fails to eject in the required time, the contacts open and the press stops.

The press control unit may also be used to automate the press and to count stamped parts.

The control may be installed on any punch press with dog, pin, or air clutch which is electrically operated or can be modified to electrical operation.

STEEL BELT CONVEYOR CREATES INTEGRATED PRODUCTION LINE

CONTINUOUSLY traveling conveyor belts can be used both as transporters and temporary storage means. If the conveyor line length is restricted, storage can be achieved by simply restraining parts on the belt, allowing a controlled pile-up to occur. The system would be provided with some gating means to control and direct the flow of individual parts from the pile-up.

As part of a production line, this type of conveyor application is particularly useful in connecting a series of individual machines which have different operational cycles. Balanced operation of such a line is obtained by employing more or fewer machines performing a given task.

Random type troubles which might take individual machines off the line temporarily are not critical. This is not true, however, for the conveyor system which links the individual machines into a production line. If the conveyor is down, parts must be handled manually. Thus, conveyor system maintenance is a critical item—complicated by the fact that for this type of installation there is an abnormal condition at the point of controlled pile-up where the moving belt must resist the wear and tear of passing under stationary parts.

This problem has led the Chrysler Corp. in its Mound Road engine plant to adopt steel belts for conveying automotive pistons between machining operations. The 24-inch wide, 0.063-inch thick steel belt system, furnished by Sandvik Steel Inc., is part of a production line comprising 43 machine tools located alongside the 360-foot long conveyor. Seven machining operations are performed: Rough turn, 4 machines; saw, 4 machines; rough bore, 5 machines; mill, 3 machines; finish bore, 11 machines; grind, 13 machines; and mill to weight, 3 machines. The pistons are produced for Plymouth engines at the rate of 1200 per hour.

As the first machining operation is completed, the piston is conveyed vertically by means of a flight conveyor to a spiral chute which delivers the piston to the steel belt conveyor. The chute deposits the piston on the belt, head down, between guide bars which direct the piston to a discharge chute leading to next machining operation in the cycle. This type of transfer between machines is used for the seven machining operations, resulting in a finished machined piston ready for a tinplating operation that follows. At points of controlled pile-up, the steel belt conveyor easily passes under the workpieces without damage to itself or the parts, thus eliminating torn or worn belting as a cause of downtime.

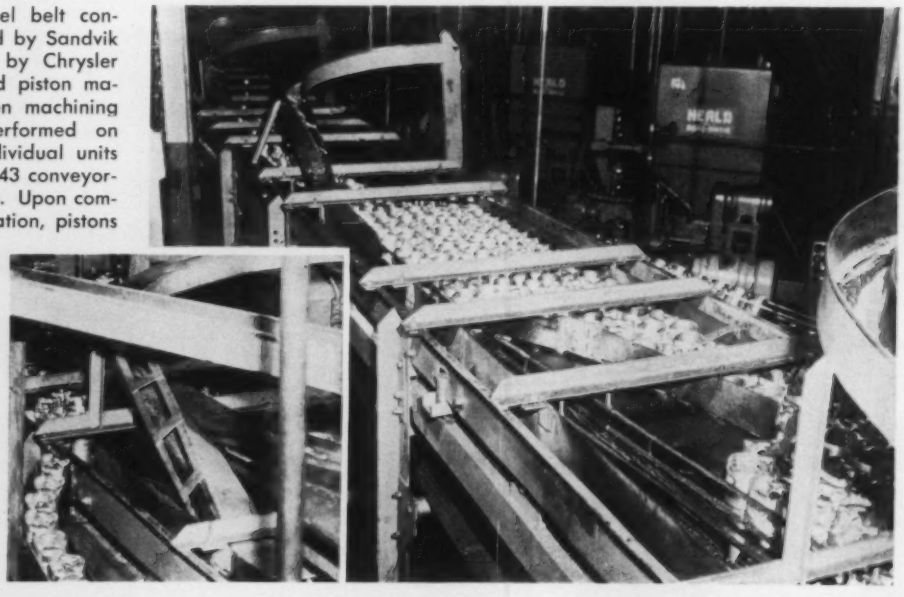
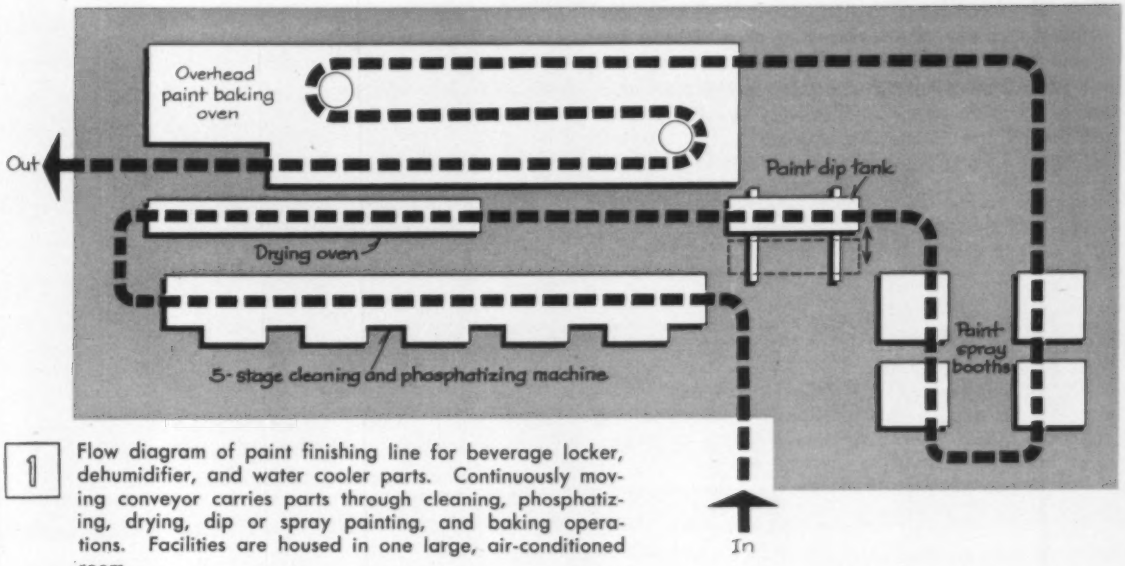


Fig. 1—Endless steel belt conveyor manufactured by Sandvik Steel Inc. is used by Chrysler Corp. in automated piston machining line. Seven machining operations are performed on each piston by individual units within a battery of 43 conveyor-connected machines. Upon completion of an operation, pistons are discharged onto the steel belt conveyor and directed by guide rails to outlet feeding next operation in line. Because continuous belt is steel, it resists wear at outlet points where pistons pile up.



1 Flow diagram of paint finishing line for beverage locker, dehumidifier, and water cooler parts. Continuously moving conveyor carries parts through cleaning, phosphatizing, drying, dip or spray painting, and baking operations. Facilities are housed in one large, air-conditioned room.

AUTOMATION TODAY

CONVEYORIZED PAINTING LAYOUT

COMBINES CONTINUOUS FLOW AND FLEXIBILITY

CONTINUOUS FLOW of parts through the processing steps is basic to economical and efficient mass production of manufactured goods of all kinds. The flow path, as established by plant layout, also has an important bearing on costs and efficiency through its effect on floor space and conveyor length requirements.

The paint finishing line at Ebco Mfg. Co., used for cabinets and accessory parts for beverage lockers, dehumidifiers, and water coolers, exemplifies intelligent application of both principles—continuous flow processing and efficient plant layout.

Facilities for cleaning, phosphatizing, drying, dip painting, spraying, and baking are housed in one large room. A single overhead conveyor brings parts into the room, carries them through the processes, and delivers them to work areas outside the room. Refiltered, conditioned air is introduced into this room from the rest of the factory area. The effect is that, despite the presence of drying and baking ovens, temperatures in the paint room are nearly optimum for worker comfort.

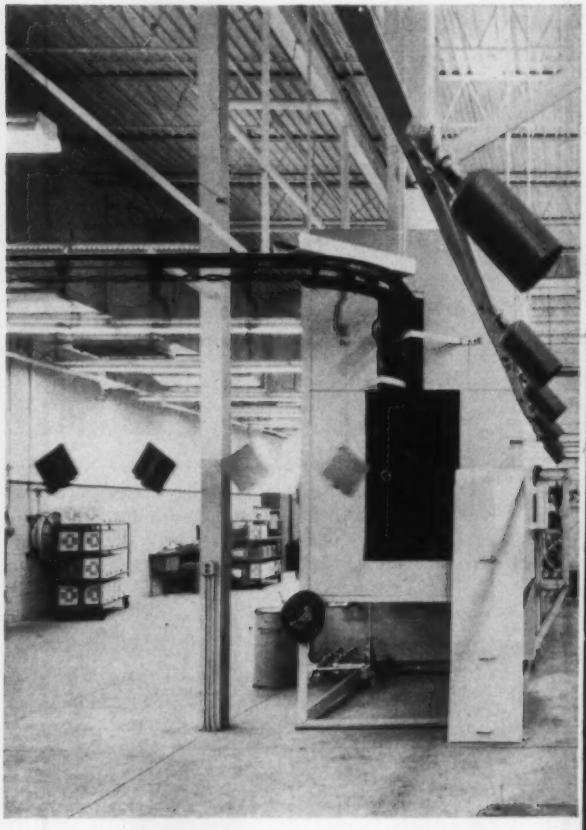
A carefully planned layout of conveyor, dip tank, and spraying booths provides needed flexibility of operation to suit the finishing specifications for different parts. Condensers, cooling fins, beverage locker frames, and water cooler bases, for example, require dip painting; dehumidifier covers, water cooler and beverage locker cabinets, on the other hand, call for spray painting. Both finishes can be provided by the layout.

For dip painting, a tank can be rolled into position under a vertical loop of the conveyor. When parts are to be spray painted, the dip tank is rolled away, and parts pass directly to the spray booths.

Equipment for heating the paint and controlling its velocity assures uniform quality of finish. Paint for finish spraying is piped to pressure tanks adjacent to the finishing booths; primer is supplied directly to the spray guns at the primer booths. All

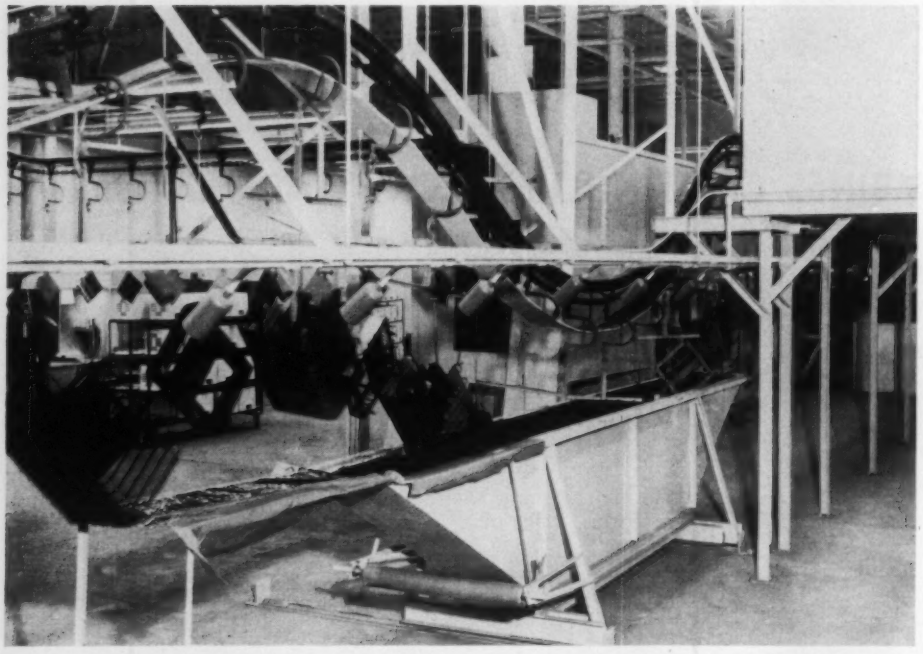
paints are formulated so that the baking time and temperature can remain the same regardless of the type of finish applied.

A control laboratory in the plant is equipped with test facilities to check qualitatively several characteristics of the finishes produced: Gloss, impact resistance, conical mandrel test results, and hardness.



2

Parts entering the finishing process are first conveyed through the five-stage cleaning and phosphatizing machine at left. This machine cleans the metal and applies a corrosion resistant phosphate coating. A rotary, multiple-arm mechanism containing spray nozzles thoroughly saturates every surface of the parts with cleaning solution. Each of the five operations performed in this machine takes approximately 40 seconds: 1. Clean with commercial cleaner at 150F. 2. Hot water rinse. 3. Phosphatize with commercial preparation at 150F. 4. Cold water rinse. 5. Final rinse with prepared solution. Following the cleaning and phosphatizing processes, the conveyor carries the parts through a drying oven, center background. This unit employs a dual-conversion type burner that is normally operated on gas, but which can be converted to use fuel oil under emergency conditions. Temperature in the drying oven is maintained at 300F, and conveyor speed and length are such that parts remain in the oven for approximately 5 minutes.



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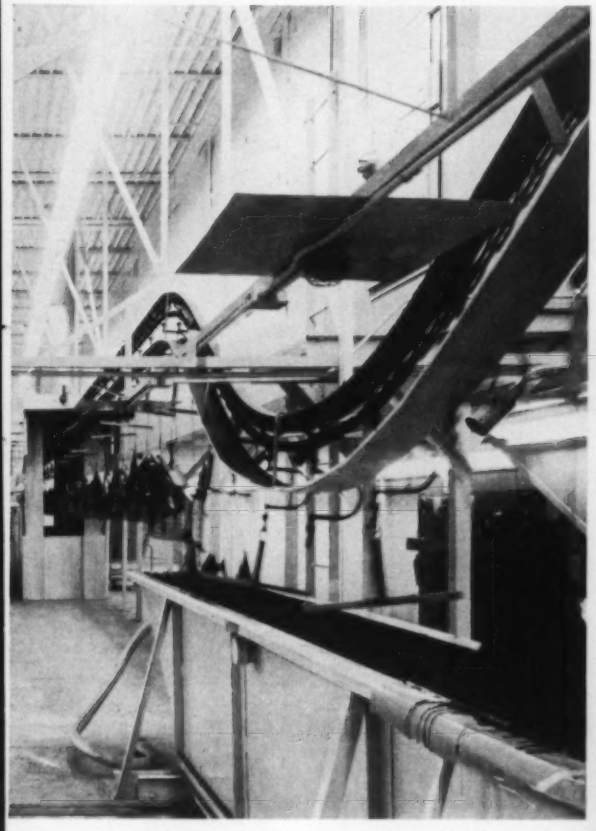
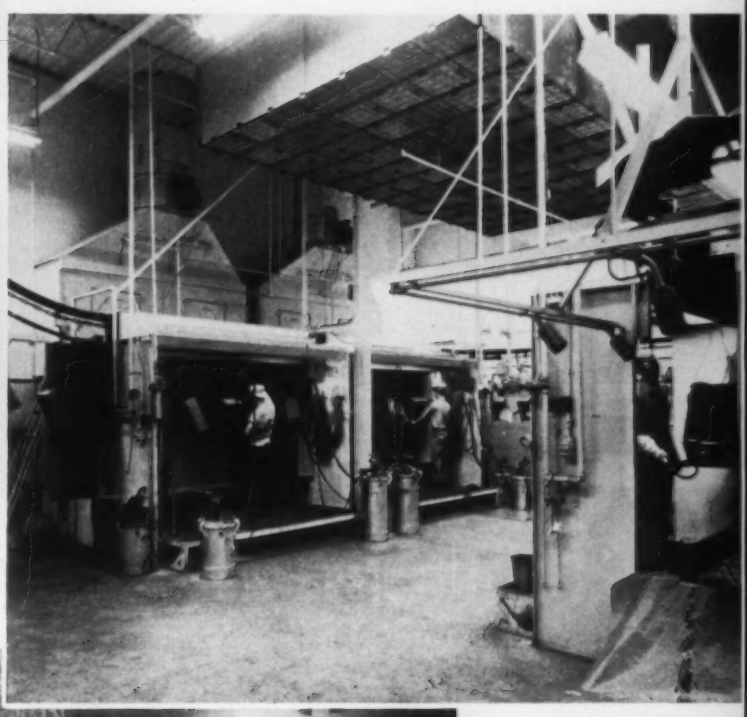
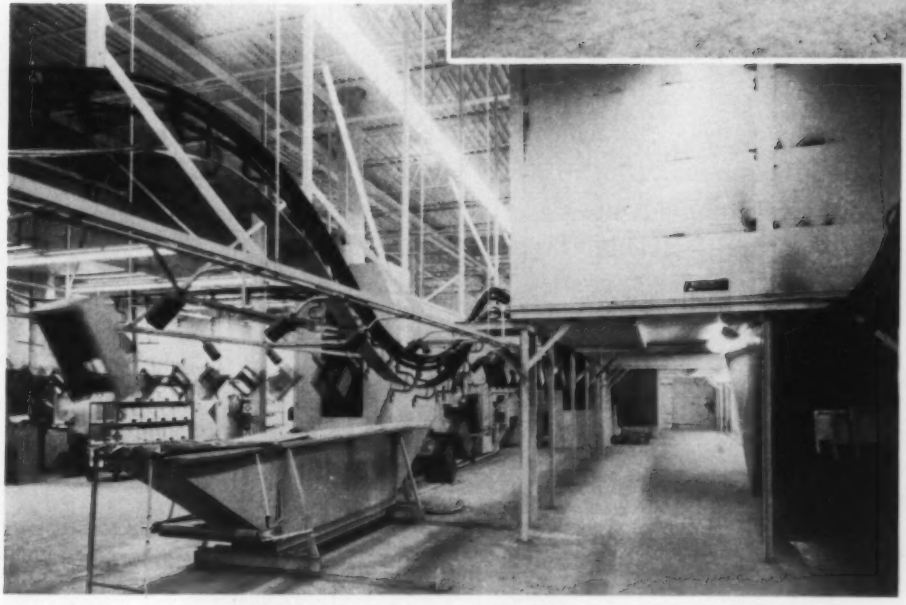
For dip painting of parts, a tank is rolled into position under a vertical loop in the conveyor shortly after the drying oven. Parts are lowered by this section of conveyor into the tank, and receive a black Japan coating. Batteries of carbon dioxide nozzles installed on each side of the dip tank automatically provide fire protection. Dip painted parts receive no additional processing until they enter the baking oven approximately 30 minutes later.



When parts are to be spray painted, the dip tank is rolled away from its position under the conveyor, and parts pass directly to these water-wash spray booths. Conveyor speed and length between drying oven and spray booths are such that no less than 12 minutes elapse for cooling prior to spraying. A flash primer is applied in the first pair of booths at right. Approximately 5 minutes later parts reach the second pair of spray booths at left, where a finish coat is applied. Metallic and hammer finishes are produced. After a flashoff time of 10 to 15 minutes, finish-sprayed parts enter the baking oven.

4





Painted parts enter the overhead baking oven at right. Baking occurs at 300 to 340F, and takes 23 minutes. The baking oven is adaptable to either gas or oil firing. Conversion from gas to oil can be made in 3 to 5 minutes. After baking, parts are conveyed to the main factory area where, in most cases, they are used the same day.

5

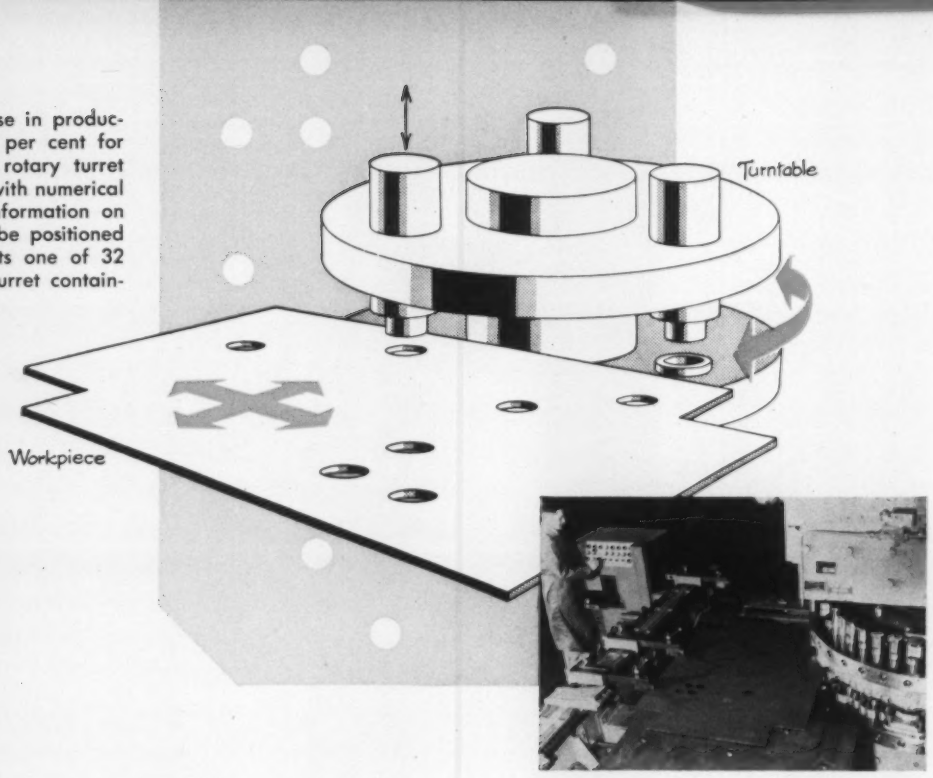


Fig. 1—Over-all increase in production has averaged 60 per cent for a Wiedemann 80-ton rotary turret punch press equipped with numerical positioning control. Information on cards causes sheet to be positioned under press and selects one of 32 possible positions for turret containing punches and dies.

IMPROVE JOB-LOT PRODUCTION WITH

NUMERICAL POSITIONING

As a measure of the concept's progress, the term "numerical control" must be qualified to distinguish between the intermittent form and the continuous form. This article discusses intermittent or positioning numerical control, potentially one of the most useful and far reaching advances in machine operation since the introduction of the electric motor.

By **STEPHEN C. CLARK, Jr.**, Specialty Control Dept., General Electric Co., Waynesboro, Va.

INCREASED ACTIVITY in the field of numerical control of machine tools is one of the most significant trends in the metalworking industries. This significance is readily understandable. As part of the broad field of automation technology, numerical control transcends the well defined area involving continuous process machining operations and embraces the more prevalent job-lot or special machining operations.

Numerical control, in simple terms, refers to a control which accepts numbers as input instructions and interprets these numbers into commands for a machine or machines. Essentially, numerical control relieves the operator from performing tedious functions associated with reading numerical information and controlling a machine's operation in accordance with that information.

Numerical controls can be grouped into two classifications: Intermittent or positioning control, and continuous or contouring control. An intermittent or *numerical positioning* control is applicable to any machine which requires positioning from one point to the next without control of the path of motion between points. Numerical data defining the individual discrete points to which the machine is to be positioned are supplied as data input. Ordinarily

there is only machining at the discrete points, as for example a drilling operation which is performed only after positioning motion has been completed. However, where all motions are restricted to straight line movements, as in a turning lathe, there may be machining while the tool is in motion along an axis.

A continuous or *numerical contouring* control is applicable for contouring machines such as milling machines for machining shapes of two or three dimensions where it is necessary to continuously control the position of the tool while in motion along any given path.

Typically, positioning, in the form of layout and setup, represents a large percentage of production time where small quantities of workpieces are involved. The information in this article applies to a means of eliminating this high cost layout time—intermittent or numerical positioning control.

▶ Field of Application

Numerical positioning control systems are applied to overcome limitations inherent in manual positioning. Such time-consuming jobs as positioning and adjusting mechanical stops, templates and tools, or laying out hole locations and cuts with hand gages, are eliminated with numerical positioning control. Numerical information taken from drawings is used directly by the control to move the tool automatically to the correct position without intermediate manual layout. The freeing of the machine for only productive work can, in most cases, more than double or triple its output.

The type of metalworking machines which can provide improved performance through the use of numerical positioning control include: Turret punch presses, step turning lathes, drilling machines, spot welders, component placement or assembly machines, milling machines (used for straight line cuts), riveting machines, shears, grinders, and boring machines.

Machines in other industries also benefit from the use of numerical positioning control. An example would be a rolling mill control for steel mills. Possible applications are also present in the plastics, paper, textile, and woodworking industries. In any machine where parts must be adjusted to a wide range of positions which can be established by a preselected program, numerical positioning control can be applied.

▶ Typical Examples

Under manual operation, an operator positions machine elements by handwheels while observing ruled scales which indicate positions. This can be contrasted to an operation in which an operator places a stack of cards into a card reader and initiates the control. Using the 80-ton rotary turret punch press, *Fig.* 1, as an example, the first card directs the table to move to the loading position and stops the machine, at which time a steel sheet is clamped on the table by the operator. Subsequent punched cards direct the table, at speeds up to 450 ipm, to any desired position with an accuracy of ±0.010 inch. To select one of 32 combinations of punches and dies, the turrets are also positioned from card data. All positioning and punching of holes, in this case up to

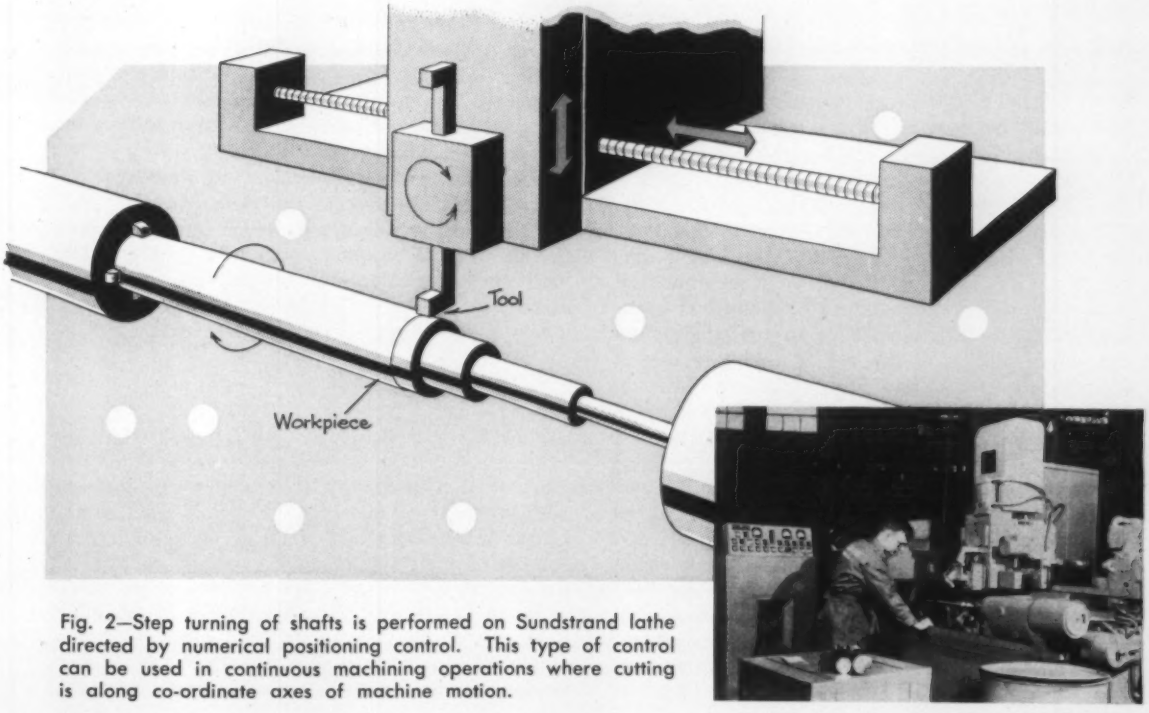


Fig. 2—Step turning of shafts is performed on Sundstrand lathe directed by numerical positioning control. This type of control can be used in continuous machining operations where cutting is along co-ordinate axes of machine motion.

6 inches in diameter, are then automatically performed until the job is completed. The last card directs the table to the unloading position where the operator removes the completed piece. He then inserts cards for the next operation. With positioning speeds up to three times faster than for manually operated machines, the overall increase in production has averaged 60 per cent even with loading and unloading still performed manually.

Numerical control of straight line cutting operations has been achieved with the multicycle production lathe shown in *Fig.* 2. The roughing cut in the step turning of hot rolled steel shafts is performed with carbide tools as the carriage moves longitudinally. Feed rates varying from 3 to 30 ipm for both the carriage and cross slide are programmed from numerical data in punched cards. The operator inserts into the card reader, as shown in *Fig.* 3, a stack of cards which has been prepared by the planner directly from part drawings. In all machining operations, first the carriage is numerically positioned, to a repetitive accuracy of $\pm$ 0.0025 inch, from the punched card data. Then the proper tool is selected and indexed. The cross slide is numerically positioned, to a repetitive accuracy of $\pm$ 0.0005 inch, for the proper depth of cut. At the end of cut the cross slide is retracted at 60 ipm. Subsequent punched cards return the carriage at up to 300 ipm to start the next cut. Finishing tools are indexed and facing operations are selected from punched card data until the cycle is complete and all cards have been read. A shorter lead time is achieved by a 5 to 1 reduction in setup time over tracer type lathes, and a reduction from 20 hour template preparation time to 3 hour card preparation time. This makes it possible for the numerically controlled lathe to produce 10 parts before the first part would be produced by a tracer lathe. Machining time is improved since numerical control is self-checking and micrometer measurement of parts is not required after each cut.

A spot welding machine, *Fig.* 4, combines numerical positioning control and resistance welding control to achieve automatic operation from numerical data punched in paper tape. The cylindrical workpiece is held in a fixture which permits longitudinal and rotary motion of the cylinder with respect to the welding electrodes. From numerical data in the punched tape, the proper welding heat and welding times are selected. The workpiece is indexed by rotary motion to an accuracy of $\pm$ 1/64 inch on a 100-inch circumference. Within a possible 100-inch longitudinal travel, the part is positioned to an accuracy of better than 1/64 inch at a rate of travel of 150 ipm to weld a complete line of spot welds, before again rotating the workpiece in the sequence selected from information in the punched tape.

A special conductor milling machine is an example of numerical positioning of more complex machines. In this case, 15 separate machine motions

Fig. 3—Data input for numerically controlled lathe shown in Fig. 2 is by punched cards. System permits individual cards to be replaced if design changes occur.

are numerically controlled. The purpose of the machine is to perform a variety of milling operations and to do slug inserting and staking operations on extruded sections of copper from 8 to 29 feet long, 2 inches wide, and 1 inch thick. Six traveling carriages move over the work table, each performing a separate function such as cleaning, slug inserting, milling, and cutoff. Each carriage has a longitudinal feed and a cross feed which positions the work head transversely. The feeds move along straight lines in accordance with numerical information on punched cards. Two card readers at the operator's console simultaneously supply numerical data to the control cubicle, which controls the position of the carriage to repetitive accuracies of $\pm$0.005 inch at 300 ipm.

These examples of applications of numerical positioning control indicate the wide range of positioning speeds and accuracies which can be obtained. For the sake of economy, both in control cost and machine construction, the systems are made only as accurate as the job requires.

Machine Motions

Numerical positioning control is suitable for controlling both rotary motions and linear machine motions of any length. It is only required that the position pickup units, *Fig.* 5, reflect the motion. Linear motions are converted to pickup unit shaft rotation by rack and pinion gearing or by lead screws. Rotary motions can be suitably geared directly to the pickup units. Motion is accomplished at a preset top speed or at some lower adjustable speed. The maximum rate of feed for which positioning can be accomplished will depend upon the

positioning accuracy required, with greater accuracies requiring slower positioning speeds.

An unlimited number of movements can be handled by the control for a single machine. Since the reading of data can be accomplished during a machining operation, the machine is usually ready to move to the next position without any delay upon completing a machining operation. All motions can occur simultaneously or the motions can be controlled sequentially in any desired order as established by the programmed information.

Motions are measured as absolute values from an established zero index position. The work should be located on the machine so that a zero reference on the work coincides with the zero position of the motion, or provisions can be made in the control for adjusting the zero points to coincide after the work is in place. Measurements are not made from a previous position since this would cause accumulative errors.

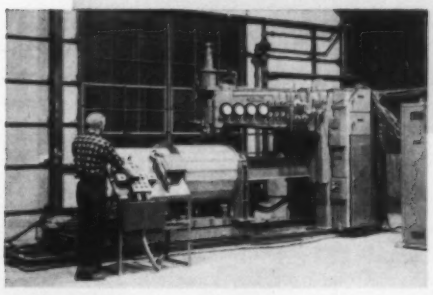
Functional Description

Obviously, to position a machine, the control must direct the machine to move in the proper direction toward the desired position. In order to do this the control must be supplied accurate information as to the position of the moving parts. This information is commonly referred to as position feedback and may be obtained from many types of motion transducers which convert machine position to electrical feedback signals. Among those used with numerical positioning control are digitizers, pulse generators, and multiturn potentiometers. In the General Electric numerical positioning control system, reliable and industrially proved selsyns are used as position-sensing or feedback devices. A multiple-selsyn system is used for each motion to be controlled. The number of selsyns required depends on the number of digits in the specified position co-ordinate.

The fundamental function of the numerical positioning control equipment is to convert the numerical dimensions supplied as information to the control into command signals for the selsyns. If the selsyn feedback devices in the position pickup unit indicate that the machine is not at the position desired, the servo drive will cause the machine to move to the correct position.

The basic units of a numerical positioning control include a data input, a director, a servo drive, and position pickup units which are mounted on the machine. The functional block diagram, *Fig.* 6, shows the basic components required for positioning one motion. The servo drive and portions of the director are duplicated for each additional motion to be controlled.

Data input can be obtained from any one of the four types of inputs shown. The director converts the digital information from the data input into command voltages for the selsyns. These command voltages represent desired positions of machine elements. If an element is not in correct position, an error voltage will be sent back by the feedback selsyns. The error voltages of each of the selsyns are mixed and the composite error signal is analyzed in the discriminator to determine the amount and direction of the position error. A signal is then provided to the servo drive control to position the machine at a speed proportional to the amount of error and in the proper direction. Any one of several basic types of servo drives—dc motors controlled by Amplidyne generators or thyratron rectifiers, ac motors, or hydraulic motors or pistons—may be used depending on machine requirements. All of the drives operate so as to move the machine into position and stop only after a signal from the director indicates that the motion is within specified limits of its desired position.



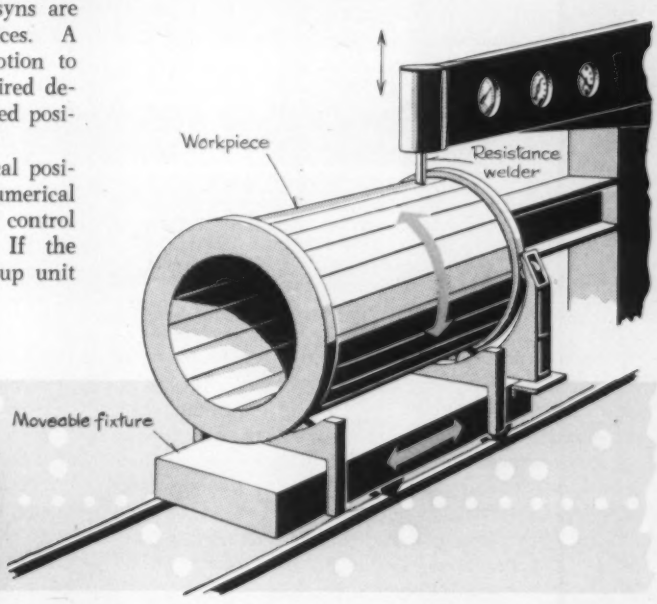


Fig. 4—Resistance welding machine manufactured by National Electric Welding Machine Co. has been equipped with punched tape actuated numerical control. Both rotary motion and longitudinal travel of workpiece relative to welding head are controlled by information punched in tape, as well as welding heat and dwell time.

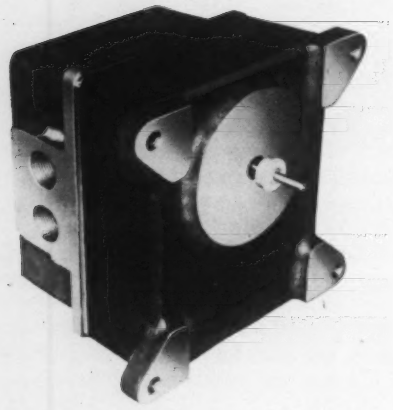


Fig. 5—Position pickup unit is geared to machine motion being controlled. Information sensed by pickup is compared to desired position in arriving at command signal to which machine responds.

▶ Data Input

Four basic types of data input are available—punched cards, punched tape, decade switches, and telephone dial. The choice will depend largely on the requirements of the machine and the degree of automation which the user desires. Manually set decade switches and the telephone dial will make the machine semiautomatic since its operation will require the attention of an operator. Controls equipped with these devices will, however, perform positioning operations automatically after the data have been manually introduced. In this way layout time is eliminated because data can be translated directly from a drawing to machine operation. Semiautomatic operation can best be used where jobs are not repetitive and time spent on advance programming is not justified. Since the operator has control at all times, he may introduce corrections to the numerical positioning data as the operation proceeds.

On repetitive operations where it is feasible to preplan the program, punched cards or punched tape will make the operation fully automatic. The choice of cards or tape may depend upon the user's preference and the method proposed to file and handle the prepared data. The possession of business machines which can prepare data may also influence the choice. For this reason, the control should accept standard punched tape or cards with standard codes. Cards lend themselves most readily to jobs composed of a multiplicity of individual complete operations, such as drilling or punching holes and spot welding, where one card can represent one of the individual operations. Omission or addition of operations may be made readily by removal or insertion of cards.

Punched tape is ideally suited to a program requiring a series of positioning motions in a particular related sequence. Here, design changes in the part can change the machining sequence as well as the dimensions and require a new tape or changes in portions of the tape, which can be made by splicing in a new section of tape. For some applications where the machining time is short, the reading time of the tape reader may limit the repetitive cycle rate of the machine. Card readers are capable of reading as many as 80 digits on one card in one second. Tape readers read only about seven or eight digits per second. Therefore, in operations requiring more than eight digits, an increased number of operations per minute are obtained from card input over punched tape input. Hence, cards may be selected for sequence type operations for that reason.

Manually Set Decade Switches. The simplest means of introducing decimal dimensions into the numerical positioning control is through manually set decade switches. A ten-position switch and dial are provided for each digit in the position dimensions. As indicated on the block diagram, *Fig.* 6, for 3 digit numbers up to 99.9 the first dial is marked in tens of units, the second dial in units, and the third dial in tenths of units. A separate set of decade switches is provided for each motion unless the motions can be positioned in sequence using one set of dials and a selector switch to choose the proper motion.

Telephone Dial. Dimensional information can be introduced directly by dialing a telephone type dial. The digits are dialed in sequence and, as they are dialed, can be visually indicated as illuminated numbers to permit a check for corrections. Codes can be arranged and dialed to select one of several motions prior to introducing the dimensional information. Likewise, auxiliary functions can be controlled by dialing proper codes.

The pulses from the telephone dial operate a distribution stepping switch to select the particular motion or function to be controlled and are then used in a manner similar to the way signals from a tape reader are stored and used in setting up selsyn command signals in the director.

Punched Card Information. The arrangement of columns on a typical punched card is shown in *Fig.* 7. A column includes 10 digits as shown. There are 45 columns available on Remington Rand cards and 80 columns on IBM cards. To simplify card punching, only one punch is included in each column. Position information requires one column per digit and is punched into the card in easy-to-read decimal form. Linear motions are specified in inches and decimal parts of an inch. Rotary motions can be specified in degrees and decimal parts of a degree. For some applications, it may be desired to divide rotary motions into equal decimal increments of a revolution. For example, if one revolution is composed of 1000 parts, one-half revolution is represented by the number 500. Decimal parts of a revolution can be used on tool turrets which have only a limited number of discrete positions or for other rotary motions where unlimited rotation in one direction is required.

In the usual application, position information will require from 10 to 15 columns. The remainder of the columns may be used for miscellaneous informa-

tion. For example, the card in *Fig.* 7 contains the drawing and part numbers to which the position information applies. This information is not normally used by the numerical positioning control, but serves as a ready visual identification of the card. This card is for part 003 of drawing 1231678. A part selection feature can be included which will accept cards of one part and reject cards of all others.

The card will direct the carriage to a position on the *X* axis at 015.00 inches, the cross feed at a *Y* axis position of 018.00 inches and the turret at 0.5000 revolution. The sequence check indicates that this is card number 33 and therefore must follow card 32 in sequence. Operator's instruction 1 (load) and machine instruction 2 (position but do not punch) are called for. Each column permits a choice of ten operator's or machine functions. On-off functions require two holes in a card; one punch indicates *On* and the second punch *Off*. Separate columns should be used for auxiliary on-off functions which must occur simultaneously; i.e., if operator's instruction lights must be selected at the same time machine functions are required, two columns are needed even though the total number of functions may be less than 10.

Conventional business-machine cards are used. These are of standard quality and can be used approximately 200 times without card wear problems. Improved quality plastic-coated cards of almost unlimited life also are available. Cards are prepared on a standard numerical key punch. Specially printed cards may be secured to show column assignments in order to simplify punching and reading.

Punched Tape Information. Punched paper tape may be used to store numerical data in a similar manner to punched cards. The 8-hole tape, one inch wide, is favored since it permits use of a readily interpretable code and provides more flexibility than the 5-hole tape used in communications applications. Tape is punched on automatic typewriters which can also be used for producing a typed copy of the instructions contained on the tape.

Compatible with existing tape handling business machines, numerical data are punched into the tape in a binary-coded decimal form with a code consisting of the numbers 0, 1, 2, 4, and 8 as shown in *Fig.* 8. Each transverse row (across tape) represents a digit of numerical information. There are 10 transverse rows per inch of tape, each row consisting of from one to eight 0.072 inch code holes and one 0.046 inch feed hole. As can be seen from

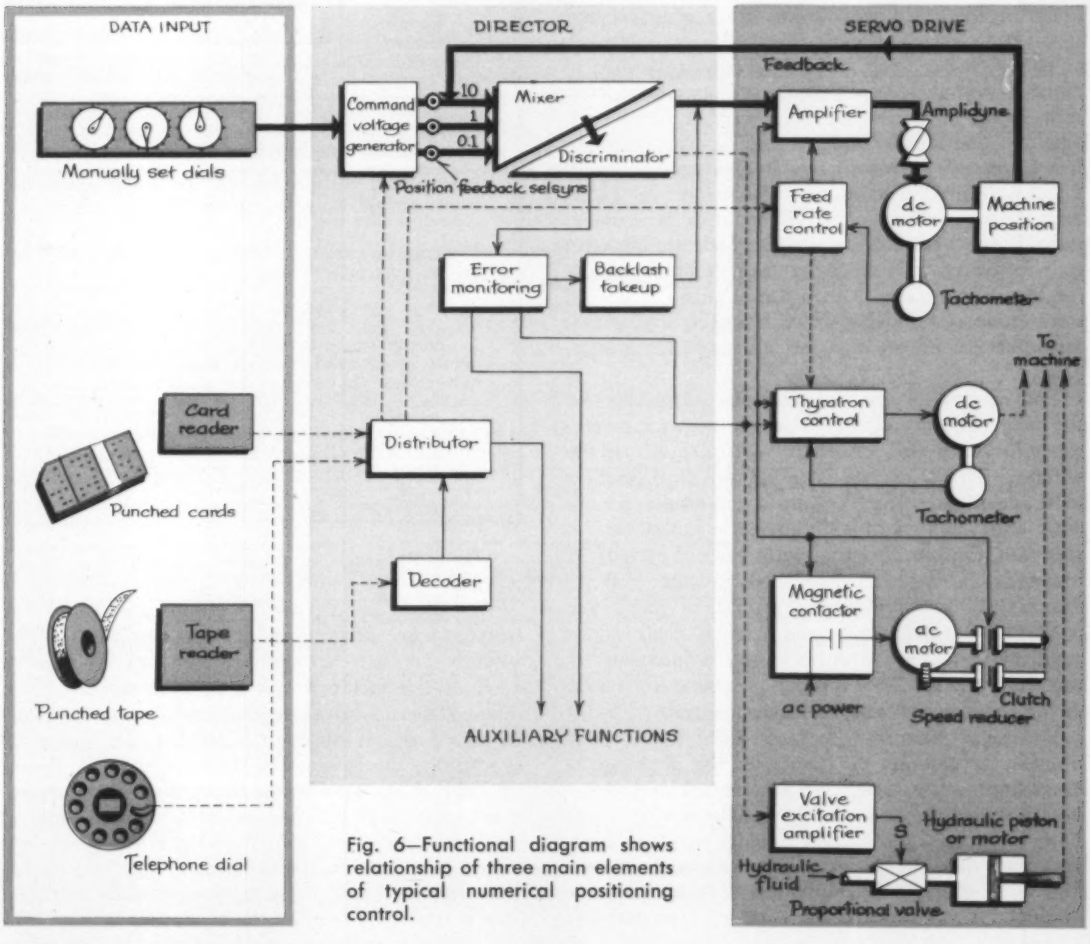


Fig. 6—Functional diagram shows relationship of three main elements of typical numerical positioning control.

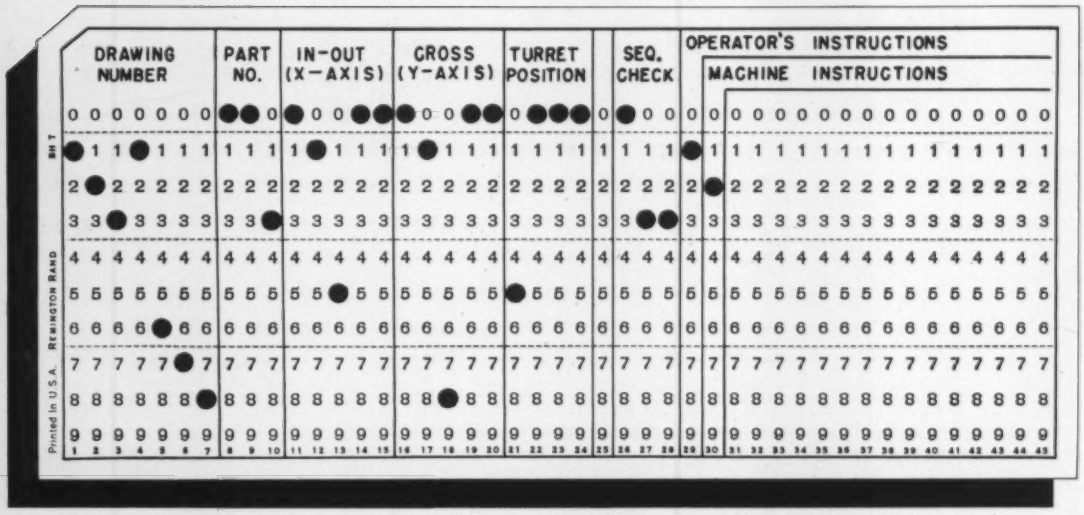


Fig. 7—Example of punched card used in numerical positioning control. This Remington Rand card has 45 columns available for information of which 30 are punched. Information in cards can be read directly; ie, the card is for part number 003; X-axis is 015.00, etc.

Fig. 8, all numbers from 1 to 9 are produced by punching combinations of from one to four holes. Between the third and fourth rows are the feed sprocket holes. The fifth row is for an odd-even or parity check. This hole is punched as needed to make an odd number of holes in each transverse row. If a signal indicating an even number of holes is obtained due to punching or reading error, the system is stopped. The sixth row is used for the number 0 and also in combination with other holes for letters and special address codes. If an error is made in punching, a *Void* code is overpunched, the incorrect code is disregarded and the tape is automatically fed to the next code. The eighth or edge row is used for a *Home* or an end-of-block signal signifying that all numerical information for one operation is complete.

The method of programming the information on the tape will depend upon the number of functions controlled and the complexity of the machine operation. This is usually a simple repetitive program such as shown in *Fig.* 8 (*a*) for a two-motion control with one simple group of auxiliary functions. In this case, the first five transverse rows of each block represent the digits of the *X* axis position and the second five rows represent the digits of the *Y* axis position. The eleventh row of each block is the auxiliary function. The home signal indicates the end of a block. This type of programming results in the simplest and least expensive control.

For more complex programs involving a large number of motions or functions, the sequence of operation may be varied and involve numerous combinations of functions. For such programs, it is possible to precede the numerical data for each function with an address code which designates the funtion to be controlled. Thus, functions may be programmed in any order or combination. For example, in *Fig.* 8(*b*), the *X* and *Y* positions, speed and tool selections are programmed in the first block. The second operation involves another position motion, such as the tool carriage, and a change in speed. The codes used for address selection represent letters in this case. If the tape is fed into an automatic typewriter, the information typed will be as shown on the line below each tape in the illustration. However, each block will appear on a separate line of the typed copy since the home signal is the carriage return signal of the typewriter.

A high grade of paper tape is normally used. It has a usable life of as much as 200 cycles, with

Advantages of Numerical Positioning Control

1. Elimination of layout time and setup time at the machine. The control converts numerical data directly into machine tool position.

2. Increased production. Operation of numerically controlled machines is limited only by design considerations—not human operators.

3. Integrated performance. All machining operations capable of automatic performance can be controlled numerically.

4. Increased machine utilization. Inserting a new set of previously prepared instructions permits flexibility in operations and rapid changeover from one job to another.

5. Constant and accurate duplication of parts conveniently obtained. Special expensive jigs and fixtures are not required for small quantity production.

6. Higher quality. Numerical control is capable of consistently holding high accuracies in machine operations.

careful handling. It is extremely easy to duplicate tapes automatically from a master tape kept on file. The tape may be readily spliced to change sections or may be formed into a loop for automatic recycling. A tumble box capable of handling up to 100 feet of tape in a single loop can be provided for recycling. Since an average block of 10 codes occupies a one-inch length of tape, up to 1200 operations can be handled and automatically recycled. Tape readers normally can handle reels containing 200 to 300 feet of punched tape. The unwind reel feeds from the center so that reels need not be rewound before using again. Laminated tapes of a tough plastic (Mylar) and paper are also available for extra long life in repeated use or for extreme reliability where over 200 cycles are required.

For short programs of up to 70 codes, 3 by 7 inch cards (which are edge punched in the same manner that tape is punched) can be fed through the tape reader. These cards are more easily handled than short sections of tape. They are also available in multiple units or continuous fan-folded packs.

▶ Selection of Servo Drives

Any machine having driven motions can have these motions controlled by numerical positioning equipment. The motions should be driven by lead screws or good quality racks and pinions to which can be attached dc electric motors, hydraulic motors, or hydraulic pistons.

The drives should have minimum backlash (preferably below 0.010 inch). However, the control will direct the machine to make its final approach from the same direction each time, thus eliminating some of the effect of backlash. New standard machines may have numerical positioning control readily added, and special machine designs are not often required.

For general applications, dc motors provide the most suitable servo drives for numerical positioning. Since they operate in proportional positioning systems, they provide high accuracies. Amplidyne generators supplying dc motors are used in systems requiring up to 40 hp. If horsepower requirements

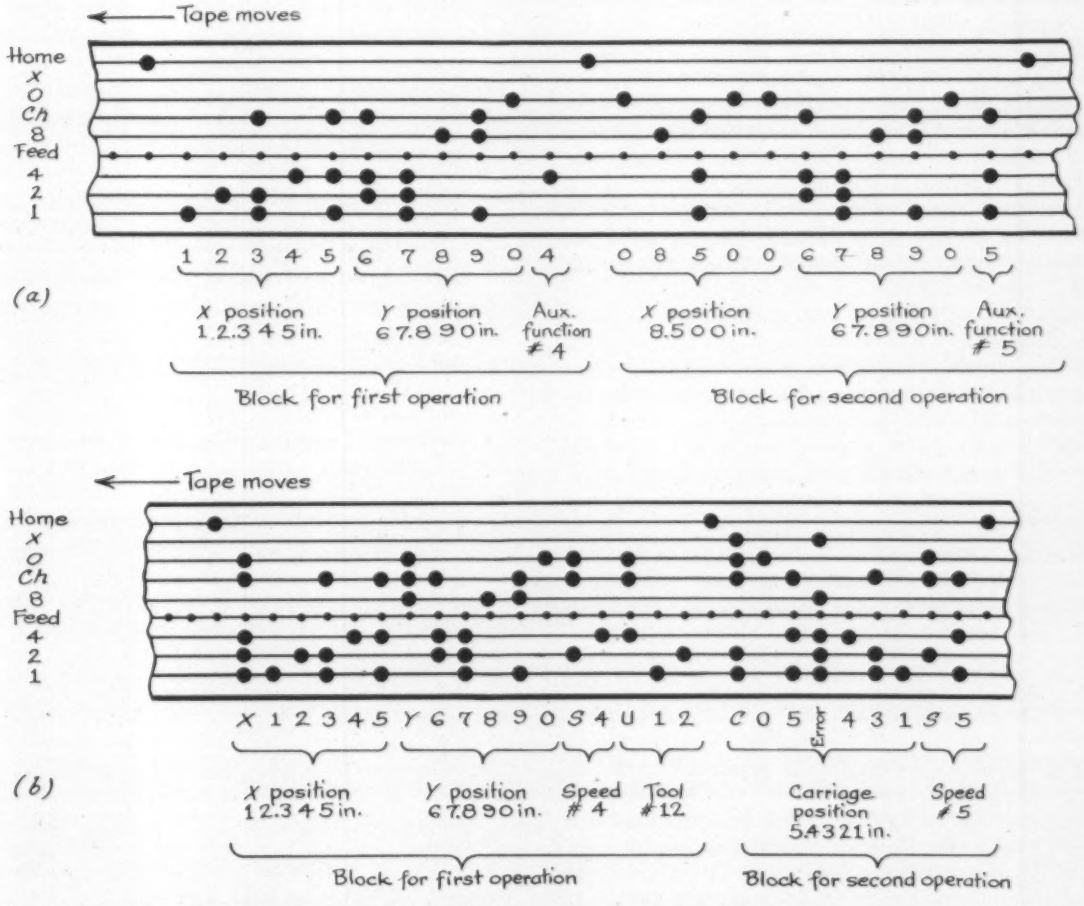


Fig. 8—Punched paper tape containing 8 channels for possible information is favored form for numerical positioning control. Numerical information is punched in binary decimal code which uses 5 channels (84210). Punch in *Home* channel marks off blocks of related information.

are low, a reversing thyratron electronic rectifier drive can be used. Accuracies are the same for both drives.

On short positioning motions with a high rate of positioning operations, it is quite possible that the duty cycle required for repeated high current accelerations and decelerations may be too severe for the dc motor. Most unloaded motors are limited to about 20 to 30 starts and stops per minute to avoid overheating. When load inertias are appreciable, the number of cycles must be even less. For such applications hydraulic drives may prove to be more satisfactory. Light masses and short strokes lend themselves quite readily to hydraulic piston drives. Positioning speeds can be higher and repetitive positioning cycles more frequent. Where proportional hydraulic valves are used to control the drive, the accuracy should be equivalent to that obtained with dc motors.

Systems using ac motors or hydraulic motors and pistons controlled by on-off solenoid valves can only initiate a stop to a motion and do not control during the stopping or check that the final position after stopping is within the required accuracy. This type of control should be limited to less accurate applications and to those having a consistent braking force either from machine friction or brakes. Since the motion does not come to a controlled stop, its rate of stopping must be quite consistent. Two-step systems are essential so that the motion may slow down to a creep before the final stop. A constant speed ac motor is used with a clutch-operated speed reducer to obtain the slower speed. It is recommended that electro-magnetic clutches and brakes be used since the consistency of their operation can be better controlled.

The positioning speeds possible with such systems are, in general, less than that obtained from proportionally controlled systems using dc motors. The use of ac motors is generally considered to be less expensive than the use of dc motors; however, when the cost of clutches and gears required is considered, this does not always prove to be true. The use of an on-off controlled drive can usually be justified only when an old machine is being modernized through the use of numerical positioning control and existing drives must be used.

Machine Design

It is possible to design the numerical control to partially compensate for some of the deficiencies of the machine. However, since compensation can never be complete, it is essential that machine deficiencies be reduced to the absolute minimum. These deficiencies are: 1. Backlash in the feed drive. 2. Windup in the feed drive system. 3. Stickiness of the machine ways. 4. Deflection of the machine members, tools, or workpiece.

Backlash in the position pickup gearing contributes directly to error but can be compensated for by backlash takeup circuits or torque motors which exert force always in one direction to take up the backlash. However, backlash in the feed drives must be kept to a minimum to assure stability. Stickiness of the machine ways has the most pronounced effect when associated with drives having considerable windup. It is the result of variation between static and sliding friction and is affected by the nature of the surfaces and the lubricant used. Good, smooth bearing surfaces lubricated with special high pressure oils help tremendously. Stickiness will cause irregular stopping and, particularly on small position changes, will cause errors. As the machine approaches a position and the machine slide tends to stick, the motor will wind up the drive shaft until enough force is obtained to move the slide. As the spring effect of windup forces the slide ahead, it may overshoot and introduce errors and instability. Tachometer feedback assures enough force to overcome stickiness, but cannot completely control the effect of windup errors.

Windup is the result of elastic deformation of machine elements in the feed drive system. It may stem from twist of screws and shafts or deflection of their supports. It is characterized as a spring effect and may be minimized by the use of sturdy, close-coupled parts and by reducing the friction opposing movement of the machine member.

Numerical control can only position accurately the part of the machine to which the position pickup units are attached. If there is machine deflection or backlash between this point and the tool that is doing the work, error will result. Deflections in a machine due to tool forces may cause inaccuracies but can be reduced by increased rigidity. Cocking and misalignment may also contribute inaccuracies and call for well-fitted parts.

A numerical positioning control and the machine it controls must be considered as a combined piece of equipment. The accuracy of the combination is the important end result. Mechanical limitations in a machine can contribute considerable errors and must be considered in evaluating overall performance. For this reason, it is generally desirable that the numerical positioning control be applied through the auspices of a machine tool manufacturer so that satisfactory co-ordination between mechanical and electrical design is attained. It is important that only the accuracies and speeds of positioning actually required and practically attainable be specified. For the most economical and effective combination of machine and control the proper evaluation of the foregoing functions is essential.

In virtually every kind of manufacturing operation, whether punching, shearing, welding, drilling, or boring, one action occurs again and again—positioning. All of the operations, whether done manually or in a machine, involve positioning the tool, the workpiece, or both, with respect to each other. Numerical positioning controls can direct this action in a superior manner with resulting advantages that commend and assure their increasing use in industry.

MODERN CONVEYOR COMPONENTS PROVIDE

VERSATILE INTERFLOOR HANDLING

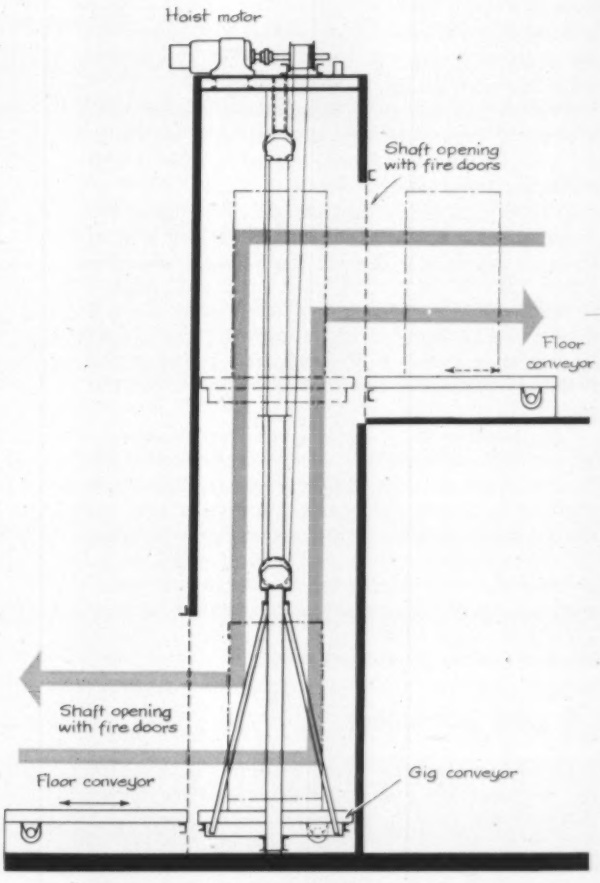


Fig. 1—General interfloor conveyor installation. A system may move loads in one or both directions and may serve two or more floors.

By **WALTER E. ENGLER**
Vice President
Gifford-Wood Co.
Hudson, N. Y.

What load from where to where? In solving this problem, today's plant can combine automatic equipment which overcomes yesterday's limitations of load size and weight, and of terminal points located on different levels.

MODERN materials handling equipment has done much to correct the illusion that multifloor plants are inherently inefficient. Today's interfloor conveying systems are designed around component equipment which provides greater versatility than ever before, increased load capacities, improved conveying speed, and superior safety conditions for loads, equipment, and plant personnel. The availability of new components or "tools" does not alter the basic approach which the system designer must take but it does intensify the planning which should precede the establishment of an interfloor system. The general problem involves a thorough knowledge of the load and the answer to the question, "From where to where?"

Concerning the load, what is its size? How much does it weigh or what is the maximum weight involved, if a variety of loads is to be handled? How is it handled? On pallets? In boxes or tote bins or similar carrying receptacles? Or as a packaged unit?

Ten years ago many loads might have been considered unmanageable, because of design limitations of the conveyor components then available. Today, by studying the specific problem and evaluating it in terms of the many components at his disposal, the engineer can design a system for a specific load. He must equate motor requirements, types of horizontal and vertical conveying elements, size of various units and the use of various types of electrical and electronic components. At the same time, he must take into account problems presented by special conditions, such as fragility of material being handled, unwieldy bulks, and increased capacities. At the present time, automatic conveyors are handling loads weighing up to 13,000 pounds and in sizes up to 300 cubic feet. These should by no means be considered ultimate capacities.

The customer asks, "How can I get my material from point *A* to point *B*?" In answering this, the engineer must ask, "How can I use the conveying tools at my disposal to solve this problem in the fastest, most efficient and most economical manner, considering all the specific requirements involved?" It should be remembered that the tools of the conveyor engineer include not only the many components at his disposal — different types of conveyors, safety devices, drive mechanisms, electrical

Fig. 2—More complicated interfloor systems are equipped with control centers to aid operator. Panel at left shows by means of lights, conveyor load routing for a 4-floor system. Panel on right contains pushbuttons which operate the conveyor system.

controls and interlocks—but his own knowledge and experience of material flow requirements.

In selecting a location for the vertical conveyor, which requires an enclosing shaft, the engineer has several possible answers. He can install his conveyor in an existing elevator shaft (that is no longer in use) if it is convenient to the user and serves the required feed and delivery points. He can erect a special shaft to house the conveyor. Normally made of reinforced steel, this shaft can be erected in an area that conforms to plant layout as well as the desired conveying stations. Recently we have begun constructing shafts on the outside of buildings, with load and unload conveyors leading back inside. This naturally conserves valuable in-plant floor space for the user, while providing him with a modern automatic handling system.

▶ Types of Conveyors

The wide range of different types of conveyors available today permits the engineer to let the specific problem determine the best conveyor possible for the installation. Live or gravity rollers, chains, belts, slats or special units can each be used for horizontal conveying into and out of the vertically moving gig, with corresponding units inside the gig for completing the horizontal transfer sequence.

Special consideration must be given to load stability, damageable or breakable loads and safety requirements. For instance, bottled goods are frequently handled on chain conveyors separated by steel plates to insure maximum load stability. Roller conveyors can be specially constructed with minimum center distances to handle tote bins or similar containers smoothly and without danger of tipping.

Normally, horizontal conveyors are installed on specially constructed frames, to give the required rigidity and provide convenient facilities for installing motor components and electrical control devices. We are currently considering installing such conveyors in the floor itself, rather than on a special frame. This can only be done under certain conditions such as when construction of the floor offers sufficient rigidity and the layout of the surrounding area provides adequate space for other components. However, such an installation can conserve vertical space and eliminate a 15-inch fork truck lift when loading and unloading.

The vertical conveying element can employ either a winding type cable or a traction unit, depending on installation limitations, housing facilities for the motor units and safety factors.

Practically every vertical conveyor is designed with provisions for leveling the unit with feed and receiving conveyors; this is particularly important where smooth transfer of glass or similar products is involved. The principle of leveling involves reducing the lift speed of the conveyor (60-100 fpm) to a leveling speed (5-25 fpm), with precision limit switches controlling the final position of the conveyor.

This leveling speed range can be provided either by a two-motor system or a single two-speed motor. In the former case, the gig contacts a switch in the shaft as it rises (or descends), which in turn cuts off the main hoist motor and starts the leveling motor. A two-speed motor, with a ratio of 4:1 or 6:1, provides the same dual action in a single unit. However, two-speed motors run to considerable size and expense in larger capacities, so two motors are usually specified for larger conveyors.

▶ Load and Unload

In setting up load-unload facilities for a system, the engineer must consider the following factors: Point of load-unload, actuation of conveyor once the load is in the system, special receiving-unload ar-

Fig. 3—Starting switch on loading conveyor which directs loads onto a vertical conveyor. The roller and spring arrangement actuates the switch as a load is placed on the conveyor.

rangements, and combination load-unload systems.

Point of load-unload. Unitized loads should be deposited by fork truck on the end of the conveyor or from either side, and removed at the other end of the system with the same flexibility. The customer's requirements for actuating the conveyor, and physical limitations of the adjacent area for positioning the load, are the primary factors that determine load paths. Conveyors and all electrical components, including necessary start and limit switches, can be designed and installed for any load direction.

Conveyor actuation. Once the load is properly positioned on the conveyor, the transfer sequence can be actuated in any of several ways. A manual pushbutton can be provided for the operator of the fork truck to start the first conveyor; succeeding conveying phases are normally interlocked in sequence with this initial conveyor. Pushbuttons can be mounted in wall panels near this first conveyor, or wired to a suspended switch over the operator's head, so he can start the sequence without getting off his truck.

Conveyors can be actuated automatically, either by photoelectric cells or a limit switch. If a photoelectric system is used it should be positioned so that the beam is broken by the movement of the loading truck. When the load is in position, the beam is restored; after a timed interval, the conveyor is actuated.

Limit switches can be installed under a spring-mounted roller at the load end of the conveyor. When a load depresses this roller, the switch is actuated, starting the conveyor motor. Similar switch arrangements can be installed for other types of conveyors, so that the load itself is the actuating force.

Special receiving-unload arrangements. Loads can be delivered to receiving floors in the same direction as they were loaded, in the opposite direction, or at an angle. In the first two cases, the control switches on the gig's floor conveyor are adjusted so that the load is delivered in the desired direction (forward or reverse) when it reaches its destination.

For delivery at an angle to the feed direction, provisions are made in the gig shaft for the gig to be rotated to the desired angle as it rises, and descends; when the load reaches the unload point, it is properly positioned for delivery. Separate provisions can also be made for separate feeding and receiving conveyors on the same floor, by means of a double-deck conveyor system. One of these conveyors receives, the other loads; this is done from a double-deck gig, so that delivery of one load and receipt of another can be performed in a single operation. This reduces the possibility of misdirecting loads because of the failure of an operator to indicate proper direction through his control panel.

Combination load-unload systems. Two-way systems are possible through proper electrical circuiting and the use of reversible or paired switches. Pushbutton controls may be installed at all stations, to reverse the direction of all conveying elements.

Such a system is normally used at installations where one-direction flow of materials (for instance, to a bottling line) continues for several hours, then a reverse flow is required for returning items (such as empty pallets, scrap or packaged items) to the original load point.

Indexing provisions on receiving or loading conveyors now make it possible for such conveyors to hold as many as 15 to 20 unitized loads before the system is loaded to capacity. In an indexing sequence for loading, each load is placed at the end of a conveyor; it moves forward one load length, then stops upon contacting a switch. Succeeding loads follow it down the conveyor in the same fashion, and each load is automatically moved forward one position as forward loads are moved into the gig. The reverse procedure is applied to an indexed receiving operation; as each load is discharged from the gig it moves forward one load length, stops upon contacting a switch, then moves forward as additional loads are received. In both cases the entire conveying system is interlocked so that no more loads can be fed into the system when all index positions are filled.

▶ Control Interlocks

Indexing is one of the many ways in which separate operations can be interlocked by electrical switching. Throughout the multiple sequences of a con-

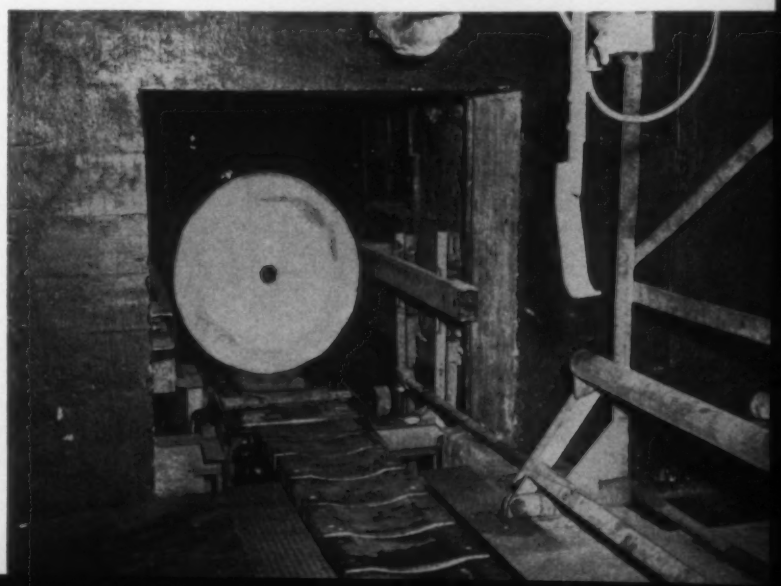


Fig. 4—Upon emerging from vertical conveyor, heavy roll of newsprint contacts arm that actuates limit switch, right foreground. Switch causes hydraulic ram to push roll from slat conveyor to incline at left leading to press room.

Fig. 5—Fork truck deposits load of tin plate on automatically indexing conveyor. As each load is deposited, horizontal conveyor indexes forward a stipulated distance; interlocks prevent movement unless gig is present to receive load.

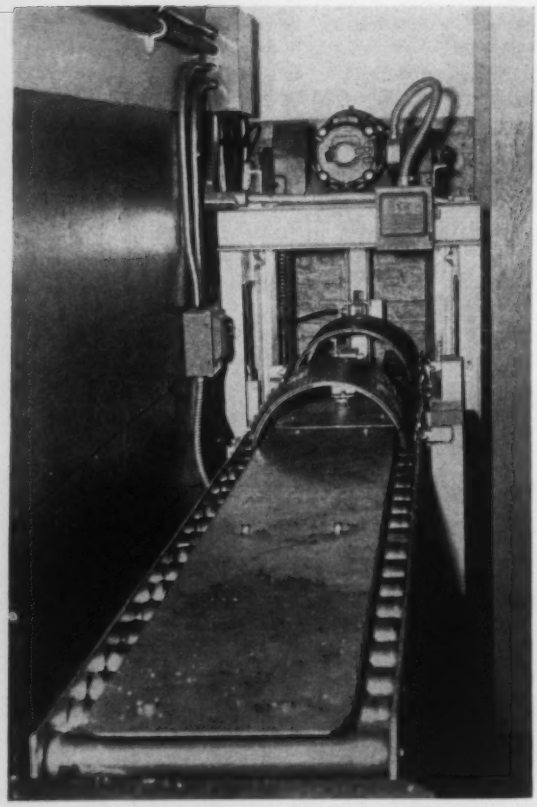


Fig. 6—Two printing plates are shown on system which moves the plates between casting and press areas. As soon as first plate is transported to lower floor and the empty gig returns, the second plate will move forward.

veyor operation, electrical interlocks are provided to give the fullest possible automatic operation, maximum speed, and smooth safe transfer of loads from one conveying element to another.

Normal interlocks in an interfloor conveying system include: Linking of two horizontal conveying elements; co-ordinating the action of gig doors, gig movement, and loading conveyors; co-ordination of lift and leveling motors; and all necessary protective devices for the system. Normally each electrical component is wired directly to a single panel, rather than by combined circuitry; this simplifies any necessary trouble shooting of electrical components after the system has been installed.

The controls on a conveyor system can be as simple or as detailed as desired, depending on the degree of control and automation the customer requires. The simplest controls would include *Safe-Run* switches, *Start* buttons, *Stop* controls and, for two-way systems, signal lights indicating direction of flow. Such pushbutton panels are installed at every control station in the system.

Complete control systems can sequence loads, record the destination of loads in a multiple conveying operation, and control signal lights and alarm systems for any or all of the phases of the operation.

All automatic interfloor conveyors must be designed and constructed in accordance with state and local safety requirements which might vary in different areas. In addition to all standard interlocking devices, safety provisions include: Safety plate for inside the gig (to prevent personnel from riding in it); slack cable switches; safety grabs or similar arrangements for insurance against faulty cables; retiring cams on gig doors; and the doors themselves. Doors can be of unitized or multiple construction, can move from top, bottom or side of door openings, and can be actuated either by the movement of the gig or by a motor. Action of doors is normally interlocked with the movement of horizontal and vertical conveying elements.

▶ Versatile Tools

The range of tools that the conveying engineer can use indicates the tremendous versatility that the manufacturer of unitized-load conveying systems can offer to his customers. The present extremes might be illustrated, in a general manner, by two installations involving our company's equipment.

In one case, a 6-ton unitized load of material can be loaded onto an automatic interfloor conveyor, transferred to any of six floors and unloaded from a receiving conveyor—all in less than 2 minutes. The entire operation, except for load-unload by fork truck, can be performed by one man from a push-button station.

In the other case, a small stereo plate, with a relatively soft and damageable surface, can be automatically transferred from casting room to printing room, 90 feet and one floor away, in 1½ minutes. The plate is delivered in a perfect scratch-free condition because of special construction and safety features of the conveyor that handles it.

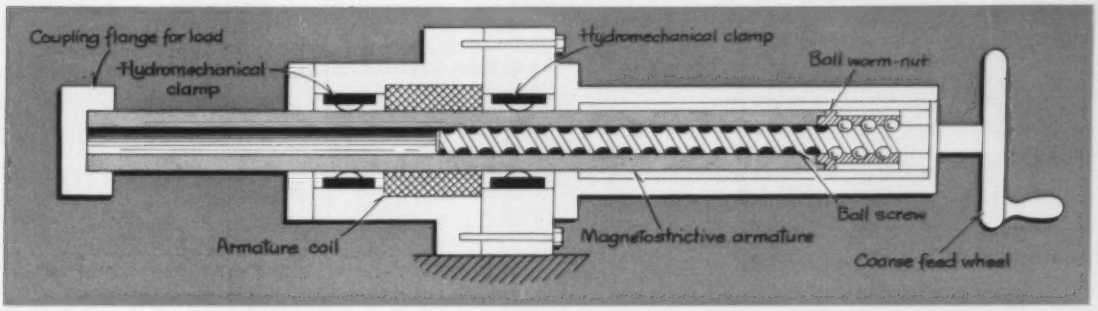


Fig. 1—Cross-sectional view of an Inchworm motor assembly shows the magnetostrictive armature, hydromechanical clamps, and actuating coil. The hand wheel and lead screw mechanism are used for original setup and coarse feed operations. After the machine tool has been set up by the coarse feed to the correct part size, minute changes in position of the movable machine element are effected by the magnetostrictive motor.

APPLYING MAGNETOSTRICTIVE ACTUATION

FOR PRECISE LINEAR POSITIONING

Conventional methods of feeding cutting tools in metal machining setups are usually based on the use of some form of the lead screw mechanism. Inherent characteristics in translating the rotary motion of the lead screw into linear motion of the cutting tool become unseen gremlins when dimensional tolerances in the range of ± 0.000005 inches are required for precision parts. A magnetostrictive actuator has been developed as a successor to the lead screw mechanism in such applications.

By **LAWRENCE TORN,** Chief Industrial Products Engineer, Airborne Instruments Laboratory Inc., Mineola, N. Y.

HIGH PRODUCTION of interchangeable parts on an assembly line basis requires the use of automatic machine tools capable of repetitive operations with consistent accuracy. In some industries this accuracy is defined in terms of tolerances in the range of ±0.000005 inch. In order to achieve accuracies of this magnitude, the positioning of the machine tool cutting surfaces with respect to their work holding systems is of the utmost importance.

A typical machine tool of today consists of a massive body built to provide a rigid system for accurate positioning and to eliminate the effect of vibration. Cutting tools are usually mounted on a heavy member which slides on accurate ways formed as a part of the machining bed. Although the slide and way system of positioning cutting surfaces is a standard method used in the machine tool industry, it possesses a characteristic known as "stick-slip" which has a detrimental effect when close control of machining tolerances is required.

In the slide and way system, it takes a greater force to start two members sliding with respect to each other than the force required to overcome a

steady-state dynamic friction between the members. Therefore, there is a minimum rate at which continuous motion can be maintained between the members. Below this rate, the motion becomes incremental and consists of a series of jogs or steps. When a device such as a lead screw is used to actuate the slide, the rotary motion of the screw must be resolved into a linear motion to move the slide on the way. Since the force that must be exerted to start the slide moving is greater than the force required to continue movement, the slide does not begin to move the instant the screw begins to turn. Instead, the lead screw "winds up" somewhat like a spring until sufficient force is accumulated to overcome the static friction of the slide. The slide then lurches forward into motion and frequently moves by an amount greater than was required to correctly machine the part. This effect becomes more detrimental as smaller and smaller advances of the slide are required to make microinch corrections to cutting tools.

To overcome the disadvantages of the "stick-slip" motion of slides and ways, Airborne Instruments Laboratory Inc. has developed a linear actuating device known as the Inchworm motor, *Fig.* 1. This device replaces the conventional lead screw mechanism and meets the fundamental need in precision positioning of large mechanical loads in small, discrete, controllable steps along a linear path. It uses a physical principle called magnetostriction to achieve precise movements of heavy loads over minute distances.

Magnetostriction is the effect that occurs when certain magnetic materials are subjected to a mag-

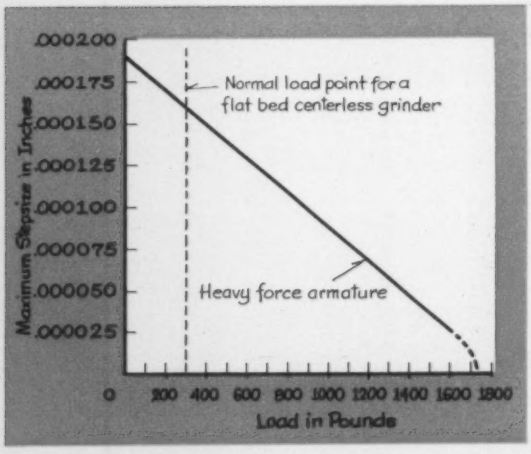


Fig. 2—Maximum step size for a particular Inchworm motor is determined by the breakloose load of the slide and the actuating coil current. The chart shown is marked for a flat bed centerless grinder which requires a breakloose force of 300 pounds and a sliding force of 220 pounds.

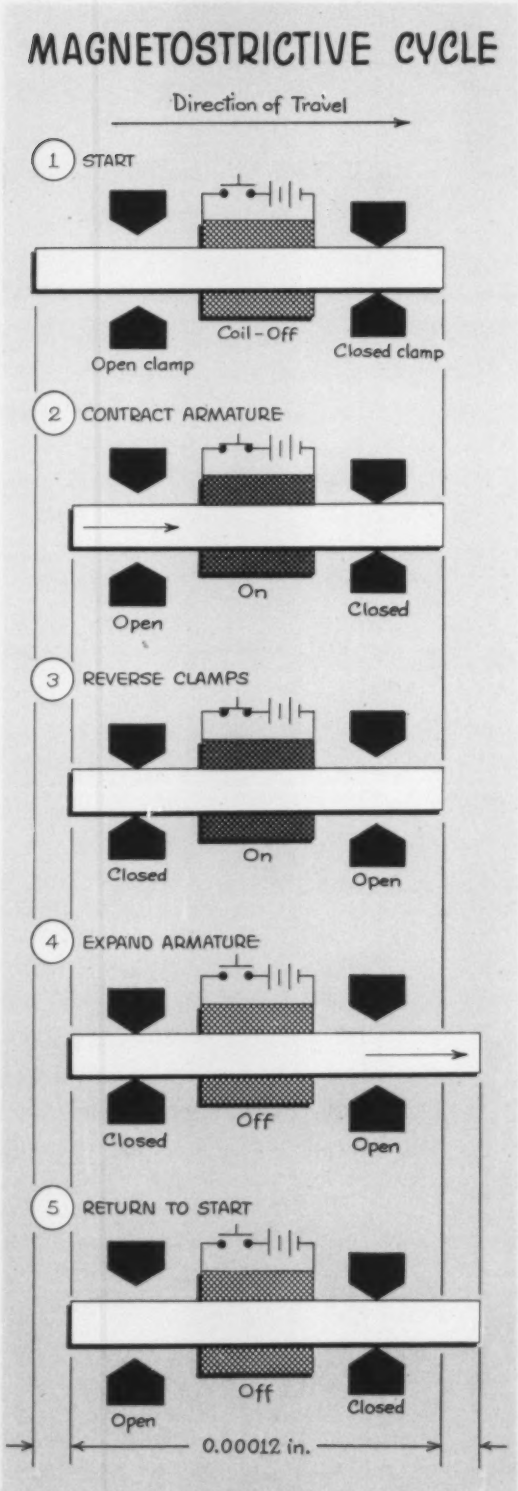


Fig. 3—One complete cycle of a magnetostrictive motor is shown diagrammatically. The actual step movement depends upon the strength of the magnetic field, the breakloose load, the type of material used in the armature, and the length of armature affected by the field.

netic field produced by current flowing through a coil surrounding the material. Under the influence of the magnetic field, the magnetostrictive material changes in length while the field is effective and returns to its original length when the field is removed. For example, a properly heat treated nickel rod can produce a magnetostrictive contraction up to 0.00003 inch per axial inch of rod length. The amount of motion is proportional to the magnetic field strength up to the point of saturation and, inversely, to the load encountered, in accordance with Hooke's Law which states that below the elastic limit the stress is directly proportional to the strain. If the rod has a four-inch long magnetic field applied to it, the theoretical maximum step size would be 0.00012 inch. In practice, the step size is approximately half that amount due to the load. Typical step sizes versus loads are shown in *Fig.* 2. The example marked is for a flat bed grinder which requires a breakloose force of 300 pounds and a sliding force of 220 pounds.

The Inchworm motor uses the principle of magnetostriction in combination with a pair of unique hydromechanical clamps. Micromotion is produced, *Fig.* 3, by locking one end of a magnetostrictive material armature with one clamp and applying a magnetic field between the hydromechanical clamps so that the armature contracts through the other unlocked clamp. The second clamp is then locked and the first clamp is unlocked allowing the armature to expand back to its original length when the magnetic field is removed. The net result is a minute motion of the armature in a direction along its length. The mircromotion may be either forward or backward and depends upon the sequence in which the clamps are locked and unlocked in relation to the on-off condition of the magnetic field.

The success of this motor depends largely upon the gripping action of the clamping devices. Each clamp consists of a fluid-filled cylindrical groove covered with membrane which contacts the armature. When pressure is applied to the hydraulic fluid in the groove, the membrane deforms and presses against the armature to form a friction lock. Release of the pressure allows the membrane to retract and permits the armature to slide freely within the clamp. The clamps on the armature may be locked and unlocked at will by controlling the fluid pressures and, in actual practice, the sequencing operation of clamping and unclamping the armature is controlled automatically.

A typical magnetostrictive feed mechanism is shown in *Fig.* 1. Mounted on one end of the magnetostrictive armature is the movable machine element to be controlled. The two hydromechanical clamps and the armature coil are rigidly mounted to the base of the machine. In order to provide a setup and coarse feed facility, a conventional lead screw feed wheel assembly works integrally with the motor through the action of ball worm-nuts. In practice, the vernier type magnetostrictive feed device overrides the ball worm-nut and allows the coarse feed to be used only when both clamps of the fine feed mechanism are relaxed.

Magnetostrictive motors have been installed on many machine tool applications in industry. One such installation was made on a centerless grinder line, *Fig.* 4, at Torrington Co., manufacturers of antifriction bearings. Applications of antifriction bearings require tolerances in the microinch range, microfinished surfaces, and extreme uniformity of every component. Maintaining close tolerances on a high-speed production line presents many problems, and Torrington engineers were interested in attaining greater precision without sacrificing output rates or quality. One operation that came under scrutiny was on the centerless grinder line where needles for bearings are ground to size and finish before assembly into finished bearings. This operation was done on a typical centerless grinder where the workpiece is carried on a workrest and positioned between a regulating wheel and a grinding wheel. The size of the part is determined by distance maintained between the two wheels. Adjustments to achieve the finished part size are made by moving the regulating wheel toward and away from the grinding wheel. The conventional method of controlling this adjustment is to move the regulating wheel by a lead screw mechanism actuated by a hand wheel under control of the operator. Since the wheel is mounted on a slide and way means, the disadvantages of "stick-slip" occurred and made control of microinch tolerances difficult.

Fig. 4—An Inchworm motor installation is shown in operation on a centerless grinder at the antifriction bearing plant of Torrington Co. The motor and automatic gaging system perform some of the observation, decision, and action functions formerly manually controlled by the operator.

In this installation the lead screw mechanism was removed and replaced by a magnetostrictive motor and automatic control system. The base of the motor was bolted to the bed of the grinder and the magnetostrictive armature was attached to the regulating wheel slide. Movements of the armature through the hydromechanical clamps move the regulating wheel forward and backward as desired. The minute movements through the device are as small as 0.000005 inch or as large as 0.0001 inch.

To make the grinding operation completely

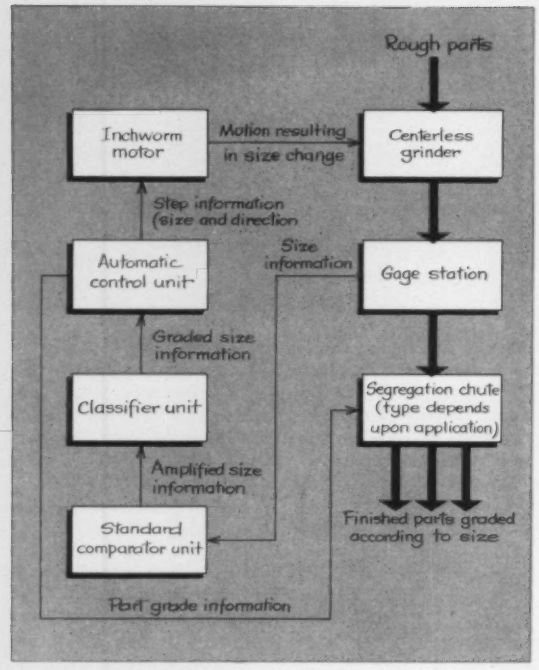


Fig. 5—Block diagram shows an automatic control system for a magnetostrictive motor installed on a centerless grinder. Parts leaving the grinder are fed through an electronic gaging unit. Size information is fed to a comparator unit and then to a classifier unit which classifies parts into seven grades, according to the level of the signal. Relay outputs from the classifier unit provide information to the automatic control unit for regulation of the motor and correction of the grinding operation.

automatic, electronic gaging equipment was added to perform the complete function of inspecting each roller after grinding and correcting the grinding machine if successive parts are out of tolerance. Machine variables such as grinding wheel wear and thermal expansion were thereby automatically compensated for, resulting in accurate part size at all times.

The automatic control system for the motor utilizes the feedback control principle to accomplish automatic size control, *Fig.* 5. Finished parts leaving the grinder are guided along a track into a gaging station. An electronic gage head measures the part and converts the part size information into electrical signals. This data is compared with the desired size through a standard comparator unit which displays the part size on a meter on the face of the comparator. In addition, the signal is carried through a classifier unit for classification into seven different grades, according to the level of the signal. This unit determines if a correction should be made through the control unit to the motor. For example, if only one part is out of tolerance, no correction is made since this may result from an accidental occurrence and may not occur in subsequent parts. If successive units are off size, the unit makes the necessary correction. The applied correction depends upon the size of error, the length of time since the last correction, and whether the part is over or undersized. Since the delay time in averaging the size of several pieces is relatively large, the control system is stabilized to compensate only for slow rate variations such as grinding wheel wear, temperature changes, and trend variations in input sizes.

The automatic control system has made it possible for Torrington to produce precision parts to an accuracy that is consistently better than fifty millionths of an inch. The improvement in size control has been achieved without any sacrifice in the speed at which parts are ground.

are you stuck?

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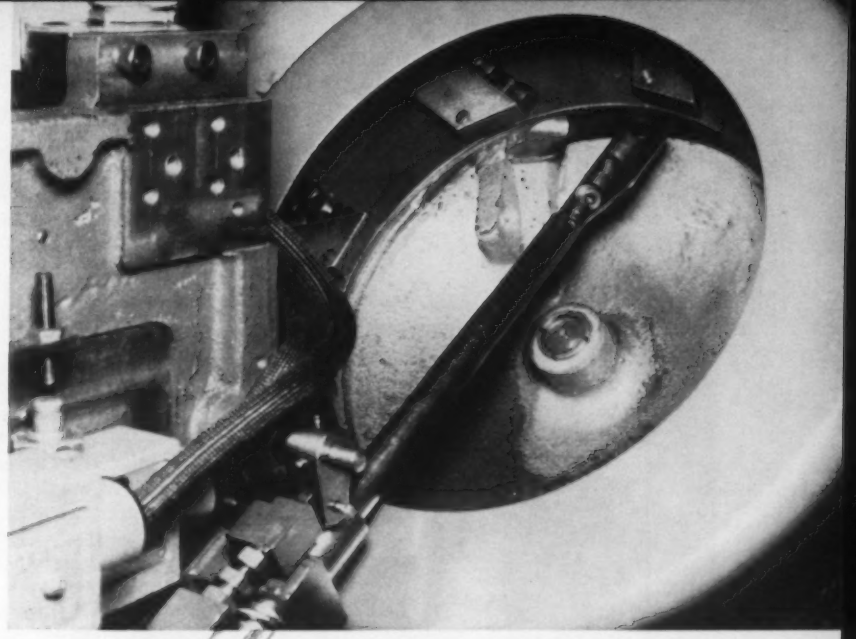
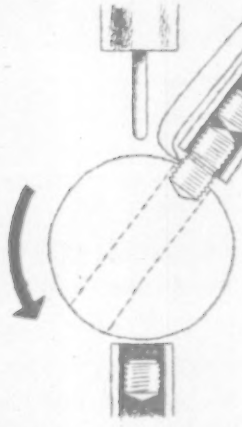


Fig. 1—Motorized, rotary bowl-type hopper feeds setscrews into the upper feed tube leading to the rotary selector drum. If jams occur in the feed tube, the rotary hopper can be swung away from the tube to allow the insertion of a rod into the tube to clear jam.

ORIENTATION BY ROTATION

FEEDS SETSCREWS FOR AUTOMATIC ASSEMBLY



Socket setscrews have always been difficult to feed and orient in automatic assembly operations due to their symmetrical shape. A new approach to this problem utilizes a probe pin detector in combination with a reversing device to effect orientation.

By **ROY GIBBS** Application Engineer, Socket Screw Div., Bristol Co., Waterbury, Conn.

FEEDING and orienting of all types of screws have become common practice in industry as increased numbers of piece-parts have been converted from manual to automatic assembly methods. Many devices have been designed to handle asymmetrical screws such as cap, round head, and fillister head in which the device can differentiate between ends of the screw by differences in diameter, weight, or shape of head. Socket head setscrews, however, present a different problem since there is only a slight variation in weight between ends and no definite head or projection for the orientation device to sense.

Considerable design effort has been expended to produce a foolproof device for feeding and orienting headless, socket head setscrews. Some devices have been designed to orient modified setscrews in which the threaded diameter varies from one end to the other. However, the necessity of modifying the standard setscrew increases the cost of the screw and either limits the number of suppliers or requires additional plant operations. Other devices have been designed to detect the slight difference in weight due to the hollow socket, but this usually results in a delicate balance system which has restrictions as to size. This is especially critical as the

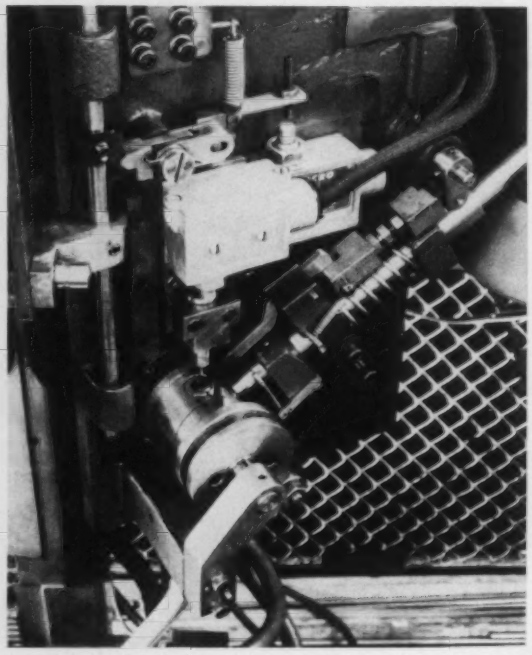


Fig. 2—Trap lever on the lower end of the feed tube is synchronized with the power screwdriving machine to release individual setscrews into the selector drum. The drum revolves to a vertical position and the probe pin descends to sense which end of the screw has been presented. The drum again revolves 180 degrees if the point end of the screw is sensed by the probe.

"square" screw shape—the length of the screw equals or is smaller than the diameter—is approached. Still other types of devices have been designed whereby the hollow socket of the screw is probed and picked up by a pin on a rotating wheel. This type of device features random selection and discard of the screw until the probe is able to enter the socket end, and the effeciency of the unit usually decreases as the shape of the setscrew approaches a "square" configuration.

New Approach

A mechanical orientation device incorporating a probe pin which "feels" the hollow socket of the setscrew as it is held in a rotatable drum and causes the drum to be reversed 180 degrees if the screw has been presented incorrectly has been designed and manufactured by the Socket Screw Div. of the Bristol Co. The feeding-orientation device is adapted for use with a standard automatic screw driving machine, and the complete combination automatically selects, orients, inserts, and drives standard socket head setscrews into tapped holes of assemblies. The unit is capable of setting the screw to a predetermined torque so that all assemblies are tightened uniformly.

The motorized, rotating bowl-type hopper of the feeding-orientation device is shown in *Fig.* 1. Socket head setscrews are picked up randomly by metal blocks inside the hopper bowl and drop into the upper feed tube. The screws slide down the inclined tube and back up against a trap lever at the lower end of the tube, *Fig.* 2. The trap lever is synchronized with the stroke of the power screwdriver to release the screws, one at a time, into a hole in the rotary selector drum when it is properly aligned with the feed tube. Upon receiving the setscrew, the drum automatically rotates counterclockwise to a vertical position, and a probe pin moves downward seeking the hollow head of the screw. If the screw is properly oriented, the probe pin extends its full stroke into the socket head and actuates a limit switch. This action causes the setscrew to be released through the selector drum into a lower feed tube which guides the screw to the feed finger of the power screwdriver, *Fig.* 3. However, if the probe pin contacts the solid metal of

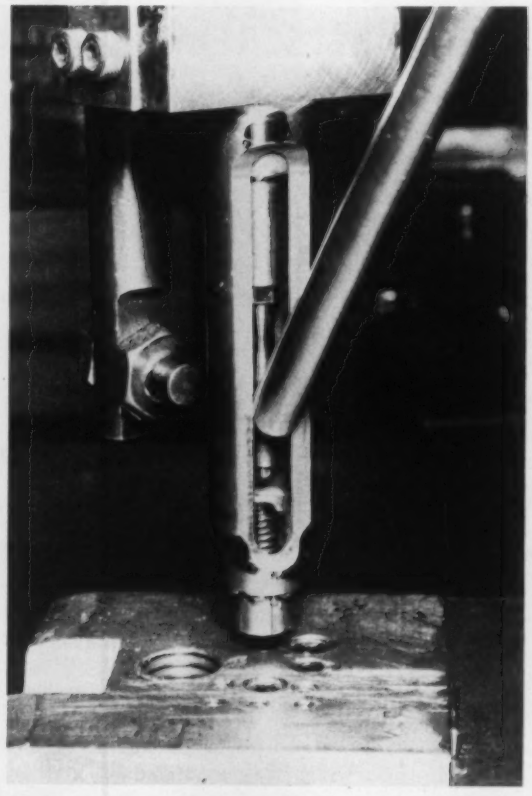


Fig. 3—Lower feed tube guides the oriented setscrew into the feed finger of the power screwdriver for insertion into the assembly. The downstroke of the screwdriver bit picks up the setscrew, and the pressure of the screw entering the tapped hole engages a friction-type clutch of the driving unit.

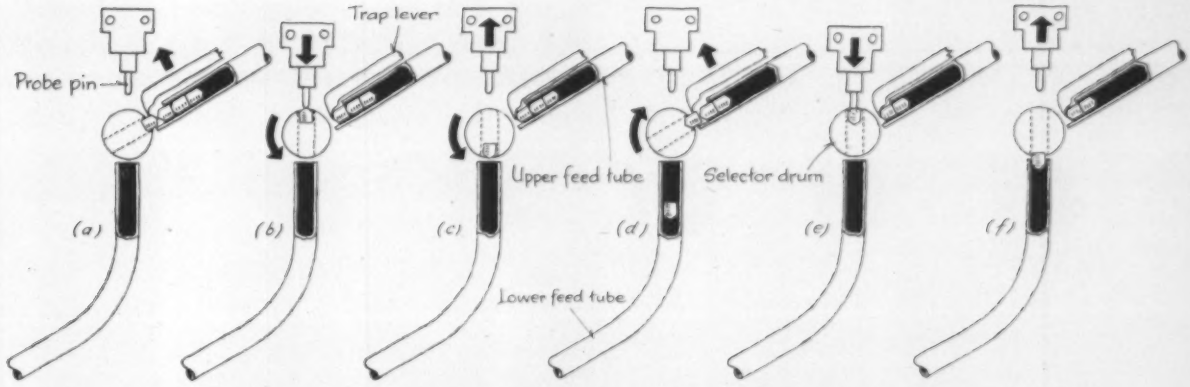


Fig. 4—Diagrammatic sketch showing a typical sequence of operations of the selector drum. *(a)* Setscrew enters selector drum *(b)* Drum rotates to vertical position and the probe pin descends and encounters point end of screw *(c)* Selector rotates 180 degrees and releases screw to lower feed tube *(d)* Drum reverses to starting position and accepts another screw *(e)* Drum rotates to vertical position and probe pin enters hollow end of screw head *(f)* Drum releases screw to lower feed tube through selector drum.

the point end of the screw and cannot extend its full stroke, the selector drum immediately rotates counter-clockwise 180 degrees, reversing the screw end for end. The properly oriented screw is then released into the lower feed tube. The selector drum reverses and rotates clockwise until it is oriented in proper position to accept another screw at the upper feed tube. A diagrammatic sketch of the sequence of selection, probing, and orientation is shown in *Fig.* 4.

▸ Flexibility of Operation

The feeding-orientation device is shown installed on a Detroit Power Screwdriver unit, *Fig.* 5. The orientation unit will feed setscrews at a faster rate than they can be driven, and the feed time cycle for typical setscrews such as No. 10 x 1/4, 1/4 x 5/16, or 5/16 x 3/8 inches is 1.2 seconds. In normal production the actual driving cycle of the power screwdriver is 2 seconds. The feeder-driver combination is supplied in three basic sizes and will accommodate screws between No. 2 wire size and 5/8 inch in diameter with normal ASME Class 3 fits. Normally, throughout any production run, the same size screw will be used. For changes due to variation in the length of the screw, approximately five minutes is required to change the probe pin assembly. When changing to another diameter screw, approximately 20 to 30 minutes is required to replace the upper and the lower feed tubes, switch the selector drum, change the probe pin assembly, and replace the screwdriver bit.

With manual presentation of parts, production increases up to 400 per cent are possible over manual insertion of setscrews. On automatic presentation of parts, or with pre-orientation of the tapped hole in the piece-part, production increases up to 600 per cent are practical. The feeding-orientation unit is designed to handle all standard types of socket head setscrews, including both hex and spline sockets with cup, flat, oval, cone, or half-dog points.

Fig. 5—Detroit Power Screwdriver machine with the setscrew orienting device inserts screws into a ball bearing locking ring. The hand insertion rate for this assembly was approximately 300 units per hour. The automatic feeder-driver installation increased the insertion rate to 800 to 900 units per hour.

Copper Coated Wire

HOUSED in a special building at Point Breeze Works of Western Electric Co., 600 foot long machines are used in continuous heavy copper coating of steel wire. In the picture, 25 channels of wire are being directed through a series of cells, part of a total of 32 separate treatments which wire receives. At each cell, rolls feed current to each wire and propel them through plating solution. Extremely corrosive nature of certain of the solutions of the process requires corrosion resistant materials in tanks, mixing devices, piping, and similar parts. As an example, critical parts of various sump pumps furnished by Aurora Pump Div. of New York Air Brake Co. are made of cast stainless alloy (type CN-7M or CF-8M).

Grinding Piston Pins

SIX centerless grinders have been combined to finish grind 2100 automotive piston pins per hour. The grinders, manufactured by Landis Tool Co., are standard models equipped with automatic loading, work conveyors, and automatic sizing units. Each machine in the line has a different grain and grade wheel to progressively remove less stock and grind to better finishes. Loader in foreground receives heat treated pins in rough-ground condition and automatically loads first grinder. Parts are transferred to successive machines in the line by chain type conveyors. The first four machines are connected to a common coolant system. Because of the finish requirements, the last two machines use a special coolant and are equipped with combination fabric and magnetic type coolant filters.

in action

Atmosphere Control

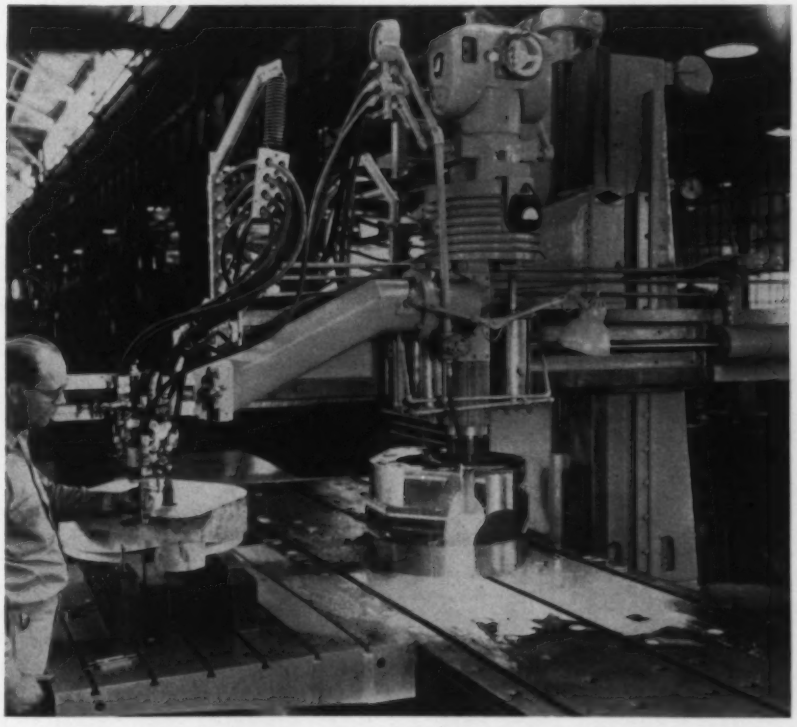
INERT GAS analyzer and control mechanism has been installed by C. G. Hussey Co. to maintain proper ratio of gases in atmosphere of annealing furnace. In this particular process, 10 parts of air are mixed with one part natural gas and burned in a generator. The products of combustion are then collected and used as an inert atmosphere. A Mine Safety Appliances Co. gas analyzer continuously samples atmosphere to determine what, if any, changes must be made in proportion of air and fuel to maintain desired atmosphere. Control mechanism then automatically actuates valves to obtain this proportion.

Programmed Tractor

FIVE heavy duty Guide-O-Matic tractors have been placed in operation at warehousing facility of Kelly Air Force Base, San Antonio, Texas. The Barrett-Cravens Co. tractors are guided over a three mile course involving five warehouses by wire embedded in the floor and ground. Before releasing a tractor, a programming panel is set up to tell the tractor where to stop. At selected stations the tractor stops and blows its horn. If within one minute nobody comes to remove the load, the tractor proceeds to next preselected station. Tractor trains are prevented from overrunning each other by block signal controls similar to those used on railroads.

Converted Machine Tool

OPEN-SIDE planer has been converted into a "new" three-dimensional tracer-controlled milling machine by National Supply Co. As a first step, the company's maintenance department converted all machine movements to hydraulic operation. A 25-hp variable-speed hydraulic spindle supplied by Romulus Tool and Engr. Co. was used to replace the planer toolmount. As shown, a sleeve was mounted on the tool spindle to support a hydraulic tracer valve. Power for both machine movements and spindle rotation is obtained from a 30-hp combination hydraulic power unit that contains a 20-gpm variable delivery pump for the spindle, and a dual pump of 11 gpm capacity for table rapid traverse and three directional feed movements.



HYDRAULIC CONTROL OF AUTOMATIC MACHINERY

SYNTHESIS OF SYSTEMS . . . 5

PRINCIPLES OF HYDRAULIC SYSTEMS ENGINEERING

By R. HADEKEL, Engineering Mgr., Sunbury Div., Sperry Gyroscope Co., Ltd., Brentford, England

REQUIREMENTS that must be met by a proposed hydraulically controlled production machine may be expressed in the form of two questions—"Will it do the job?," and "Will it do it economically?". However modest these requirements may seem, their fulfillment usually entails a detailed examination.

Doing the job means doing it effectively, and most often this is a matter of degree. In particular, a compromise is usually necessary between the technically attainable and the economically feasible. As for economics, it has been pointed out previously that this involves both first cost and running costs, including the cost of maintenance. Here, also, a balance must usually be struck.

In relation to hydraulics, doing the job may mean performing one operation, several independent operations, or a sequence of operations. Control may be merely initiated by human command, as in automatic cycles; continuously applied by an operator; or may involve a mixture of human and automatic actions.

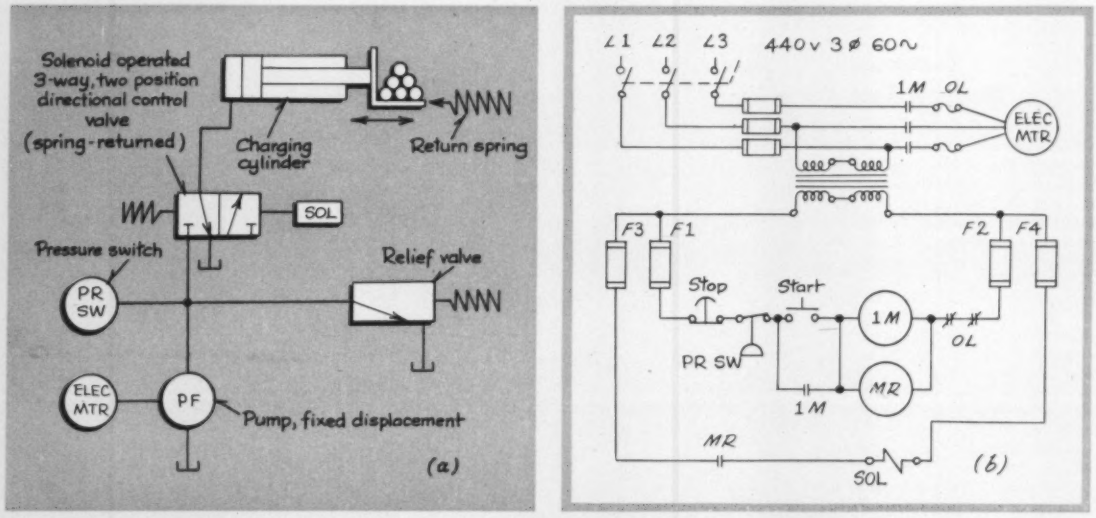


Fig. 45—Hydraulic graphical diagram *(a)* and electrical elementary diagram, *(b)*, for an automatic furnace charging device. Opening of pressure switch on pressure buildup at end of piston stroke shuts down pump motor and de-energizes control valve solenoid. Return spring then retracts piston to loading position.

Systems engineering, or that portion of over-all technical effort that concerns the integration of elements and subunits into an operating assembly, is a vital phase in the design and development of any production machine. This fifth part of a series on the synthesis of hydraulic control systems from commercially available components, describes some of the ways in which components can be combined to perform multiple, interrelated functions. Selection of system working pressure is also discussed.

The objectives are simplified when the operations to be performed are few in number and do not require continuous control by an operator. For example, in the complete stroking of cylinders, involving perhaps the phases of *rapid approach* and *press*, the aims are merely to perform the operations at the required rate and to exert the desired force with reasonable power consumption. Refinements may include adjustability of both approach speed and maximum force.

If a number of operations are to be performed in a definite sequence, it is usually a part of the specification that the sequence be achieved automatically. The methods of accomplishing this require separate study, and will be the subject of the next part of this series.

Design and placement of controls are most important when continuous control is to be exerted by an operator. The quality of "feel," as well as location to suit human physiology, are considerations that must often be taken into account. Regarding the former, excessive sensitiveness of control is undesirable. Also, extreme accuracy in the system itself is not always necessary, due to the wide tolerance of human capabilities.

If fully automatic control is required, the chief problem is accuracy. Achieving the desired degree of accuracy usually brings stability problems in its wake.

In systems which must be capable of performing a number of unrelated operations, care must be taken to insure that the operations really are independent, and do not react on each other in unwanted ways. In this connection, it must be remembered that unless the pump is very much oversized for its duties, or unless a large accumulator is used, what is available in the system is a given flow, not a given pressure. Thus, when the full pump flow is utilized, pressure will drop to the value required by the least loaded of competing services.

Whatever the system, it will have more or less prolonged idle periods, and the problem of how to deal with these is common to all hydraulic installations. The optimum solution, however, varies according to the kind of functions to be performed. The idling problem in general, and some typical means of solving it, will therefore be discussed next.

▶ The Idling Problem

It is an almost universal rule that hydraulic pumps are fitted with relief valves, although a few exceptions will be mentioned later. Also, in most applications the pump is driven at a fairly constant speed. The pump therefore is constrained to deliver a roughly constant quantity of oil per unit of time. If no free outlet is offered to this flow, supply pressure will rise until the relief valve functions. Thereafter, pressure will be maintained at the relief valve setting.

The potential energy of the fluid blowing off through the relief valve is converted into heat—if

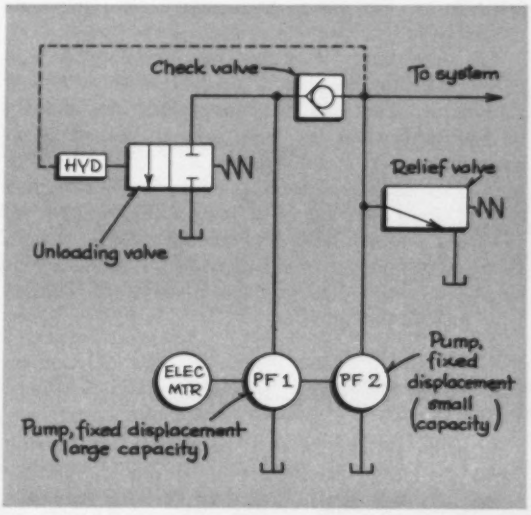


Fig. 46—Two fixed delivery pumps of different capacities are used in this pump unloading circuit. Small pump maintains system pressure and operates unloading valve during idling periods. Function of unloading valve is to bypass output of large pump to tank.

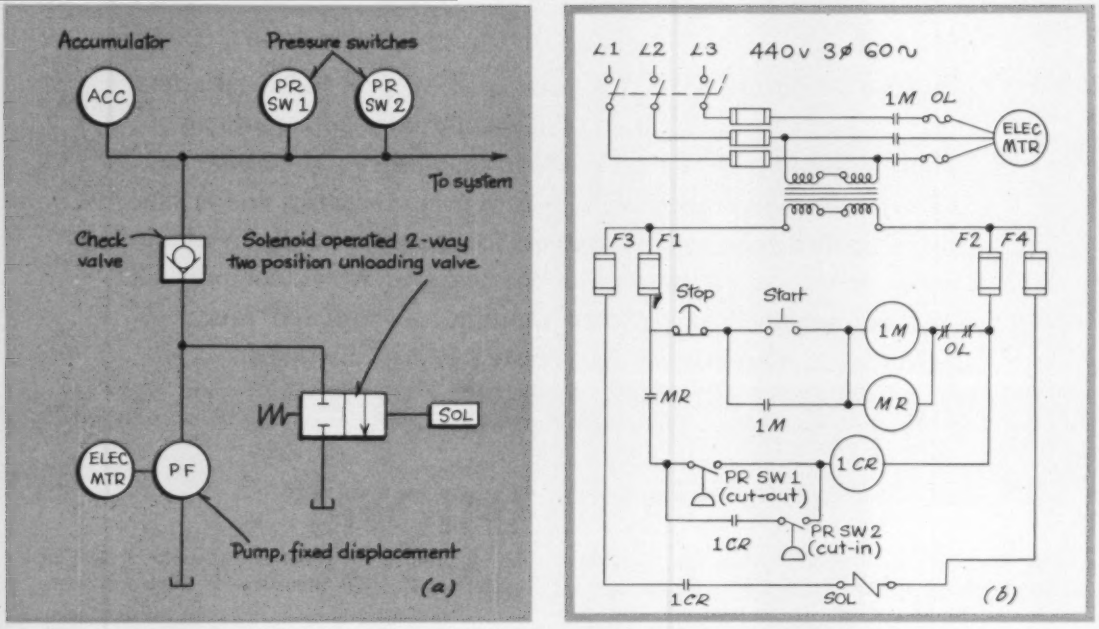


Fig. 47—Accumulator in hydraulic circuit (*a*) replaces small pump in system of Fig. 46. Pressure switches close on pressure buildup and actuate solenoid of unloading valve in control circuit (*b*). Differential setting of pressure switches avoids immediate cutting in of pump due to extraneous system leakage.

all of the pump output is blown off, then the whole of the peak pump power is dissipated in this form. Nearly all of the heat so developed goes into increasing the temperature of the oil. During the process, however, full pressure is maintained at the supply, and is available to the system when required.

There is nothing inherently wrong in blowing oil off through a relief valve during idling periods, provided: 1. The pump is capable of working continuously at full load (most high-grade pumps are). 2. Oil temperature does not rise excessively. 3. The power wastage in heat is acceptable from a cost standpoint. The last two restrictions are usually unimportant when the peak power involved is no more than, say, 1 horsepower or thereabouts. For larger powers, forced cooling as previously discussed is sometimes resorted to if cost, space, weight restrictions, and availability of cooling medium permit. As an alternative, a pump unloading system may be employed, and indeed the vast majority of installations include this provision.

▶ Pump Unloading Methods

In some systems it may be permissible to shut down the pump driving motor during idle periods when free flow stops. This may be done manually (which can be risky), or automatically through use of a pressure switch. The same pressure switch may also cause the return of the piston of a single acting cylinder if some external force, such as gravity or a spring, is available to effect the return motion. Such a system, *Fig.* 45, may be employed to load bars into a furnace.

The directional control valve in *Fig.* 45(*a*) is a solenoid operated, spring return type which requires energization of its solenoid to allow fluid to pass to the cylinder. When the *Start* button, *Fig.* 45(*b*),

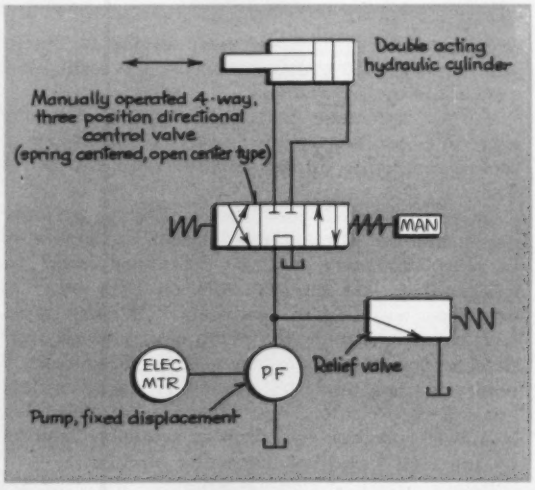


Fig. 48—Pump is automatically unloaded in neutral position of open center directional control valve used in this circuit. Relief valve establishes peak operating pressure, at ends of piston strokes.

is momentarily depressed, the pump motor is started and maintained in operation through energization and holding of relay 1*M*. At the same time, the solenoid of the control valve is energized and held in by a contact of relay *MR*. The piston of the charging cylinder thus receives pressure and extends to load the bars into the furnace.

When the mechanism hits its stops, or if a jam occurs at any point in the travel of the piston, system pressure will rise and cause the pressure switch to open. This interrupts the holding circuit for relays 1*M* and *MR*. When these relays open, the pump motor stops and the solenoid of the directional control valve is de-energized. The control valve is then returned by its spring so that the return spring can retract the piston.

The function of the relief valve in this system is to protect the pump against the effects of motor overrun after the control valve returns. Its setting must be higher than that of the pressure switch, or else the latter would never operate.

The idling problem is automatically taken care of when a pressure-governed variable delivery pump is used. With such a unit, as pressure approaches the cutoff setting, pump delivery automatically begins to drop to zero or, more usually, to whatever value is required to maintain the set pressure. In the absence of other demand, delivery is that required by any leakage paths present.

Since loads on pump bearings are proportional to pressure and virtually independent of flow, the idling power required by a variable delivery pump can be a substantial amount. In a well designed pump, for example, it can be as much as 10 per cent of the peak power developed. This compares roughly with the idling power required with other methods of unloading, and may be higher than some. The chief limitation on the use of variable delivery

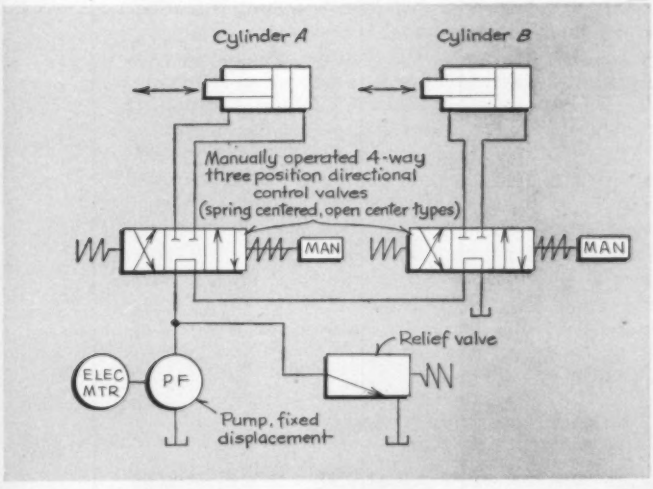


Fig. 49—Series connection of open center directional control valves effects pump unloading in neutral, and allows operation of more than one actuator. However, only one actuator can be operated at a time with this hookup.

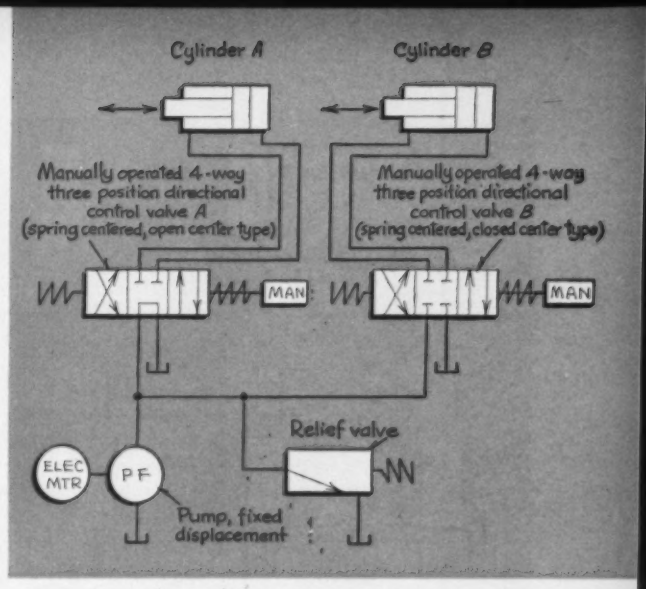

Cylinder A
Cylinder B
Manually operated 4-way three position directional control valve A (spring centered, open center type)
Manually operated 4-way three position directional control valve B (spring centered, closed center type)
MAN
MAN
Relief valve
ELEC MTR
PF
Pump, fixed displacement

Fig. 50—Operation of two actuators can be effected with one open center and one closed center directional control valve connected in this manner. Valve A must be held over (off neutral) during operation of cylinder B. Circuit is used in some injection molding and die-casting machines.

pumps to solve the idling problem is their relatively high cost.

A more common solution is to use two fixed delivery pumps that have different capacities, *Fig.* 46. These are available from several manufacturers as twin units, which simplifies installation. The smaller pump has a capacity sufficient to deal with leakage and other small demands that occur during idle periods, and its flow is allowed to blow off through a relief valve at this time. The small power dissipation involved in this action is easily tolerated.

The pressure setting of the relief valve is slightly higher than that required to operate the unloading valve for the larger pump. The margin required for the relief valve—to insure that the unloading valve will operate—represents a wasted surplus. Effective operating pressure of the system is therefore that of the unloading valve setting in this arrangement.

▶ Accumulator Systems

An automatic cutout system that uses only one fixed delivery pump is diagrammed in *Fig.* 47(*a*). In this circuit, system pressure is maintained during idling by a reserve of oil in an accumulator. The accumulator is separated from the pump delivery connection by a check valve, and a solenoid operated unloading valve is connected between the check valve and the pump. A relief valve is not essential in this circuit, since small lags in operation of the unloading valve will not cause serious pressure rises; instead, surges so developed will be absorbed by the accumulator. If a relief valve is used, as might be the case to safeguard the pump against failure of the cutout system, its setting must be above cutout pressure.

Operation of this system is as follows: Assuming the pump is operating, and free flow is restricted as

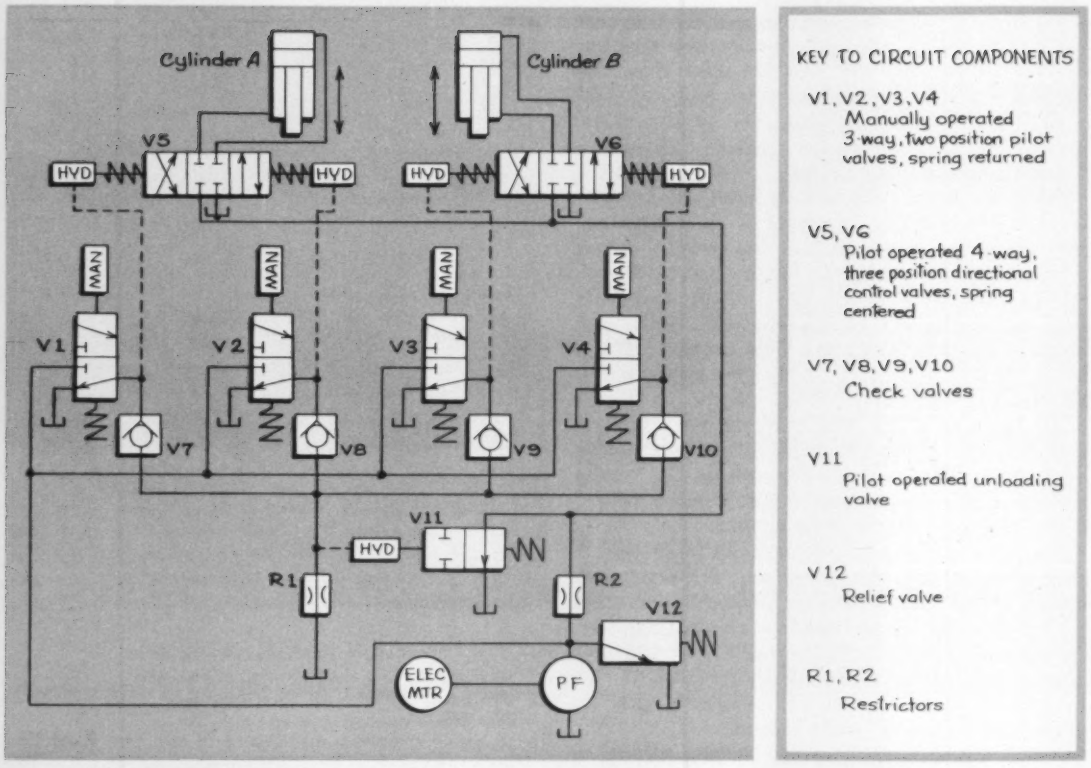


Fig. 51—A manually operated pilot valve is provided to control each *up* and *down* motion of cylinders in this circuit. Actuation of any pilot valve closes pump unloading valve and positions spool of appropriate directional control valve to operate a cylinder. Pilot valves must be held depressed for full period of piston motion desired.

during idling periods, pressure will rise sufficiently to close electrical contacts in pressure switches *PR SW* 1 and *PR SW* 2, *Fig.* 47(*a*). The pressure setting of *PR SW* 1 is higher than that for *PR SW* 2. Relay 1*CR*, *Fig.* 47(*b*), is energized by *PR SW* 1 and held by *PR SW* 2. A contact on relay 1*CR* then actuates the solenoid of the unloading valve, opening this valve, and the output of the pump is diverted to tank. Pressure is trapped in the system by the check valve and maintained by the accumulator.

This condition continues until extraneous system leakage causes the accumulator pressure to drop below the pressure settings of both switches. Opening of *PR SW* 2 interrupts the holding circuit for relay 1*CR*, the solenoid is de-energized, and the unloading valve closes. It should be noted that the pressure setting of switch *PR SW* 1, which initiates energization of relay 1*CR* and hence actuation of the solenoid, must be about 5 to 10 per cent above that of *PR SW* 2. This avoids immediate cutting in of the pump as pressure drops; even though *PR SW* 1 opens first on pressure drop, the solenoid will still be held energized through *PR SW* 2 and relay 1*CR*. Effective system pressure must therefore be taken as the pump cut-in setting of *PR SW* 2, and again the margin represents an unavoidable but small surplus.

A differential type pressure switch with an adjustable margin between operating and resetting could have been used in the previous circuit with equally effective results. Another possibility would be in the use of cutout valves that are directly responsive to pressure. Valves of this type are common in aircraft installations, but seem to be rare or nonexistent for industrial installations. This is a situation having no apparent explanation for the author.

The four systems just described—fixed delivery pump with relief valve, pressure governed variable delivery pump, dual fixed delivery pump arrangement, and automatic cutout system with accumulator—each provide an installation wherein full pressure is sustained in a delivery main, even though the pump may be unloaded. This feature is required in some setups, is desirable in others, but is by no means essential to all.

▶ Nonpressurized Systems

Different solutions to the idling problem may be more convenient where there is no call to maintain system pressure during idling periods. In general, there are two methods of attack, the choice of which depends on the type of system involved.

The first approach is applied in systems in which

automatic control of a number of operations is required, and the operations must be performed in a predetermined sequence. In this case, the sequence control is usually arranged so that initiation of the cycle puts the pump on load, and completion of the last operation in the sequence unloads the pump. Here, again, loading and unloading of the pump can be effected by closing or opening a tank bypass path. Pump unloading methods for this type of system will be discussed in conjunction with automatic sequencing circuits, to be covered in the next part of this series.

If the installation is one which involves a single operation, or a number of independent operations, the pump may be put on load by the operation of any control device in a manner to cut off the bypass path to tank. Unloading is then accomplished by returning the device to its normal position, thus re-establishing the bypass path. Return of the control device to normal should preferably be effected automatically upon its release. In directional control valves, this can be accomplished by springs. Principles involved in this solution to the idling problem can be demonstrated by considering some systems that employ open center control valves.

▶ Open Center Valve Systems

As previously described, the elementary open center directional control valve establishes a connection between its pressure (P) and tank (T) ports when it is in its neutral position. *Fig.* 48 illustrates control of a double acting cylinder by means of an open center valve. The pump is automatically unloaded to tank in the neutral position of this valve. To insure that neutral is reached, a spring centering type of valve is used. The relief valve determines maximum system pressure.

A limitation of open center valves is that they cannot be connected in parallel to control more than one actuator, since the pump would be unloaded as long as any one valve in the hookup remained in neutral. However, it is possible to connect them in series, *Fig.* 49. With this arrangement, the restriction arises that only one actuator can effectively be operated at a time; before another one can be operated, the valve causing any previous actuation must be restored to neutral. When any valve except the first one in the series is operated, all valves upstream of it will be deprived of a tank outlet.

These shortcomings may be overcome by using closed center valves that contain additional two way valve sections that are open to tank in their neutral positions. This type of valve was described previously in this series, and its hookup illustrated in *Fig.* 33 (See Part 3—AUTOMATION, Dec. 1957). Simultaneous operation of several actuators is readily accomplished with this arrangement.

It is also possible to use one open center valve in parallel with one or more closed center valves, *Fig.* 50, provided they are operated in a definite sequence. In the circuit of *Fig.* 50, for example, the

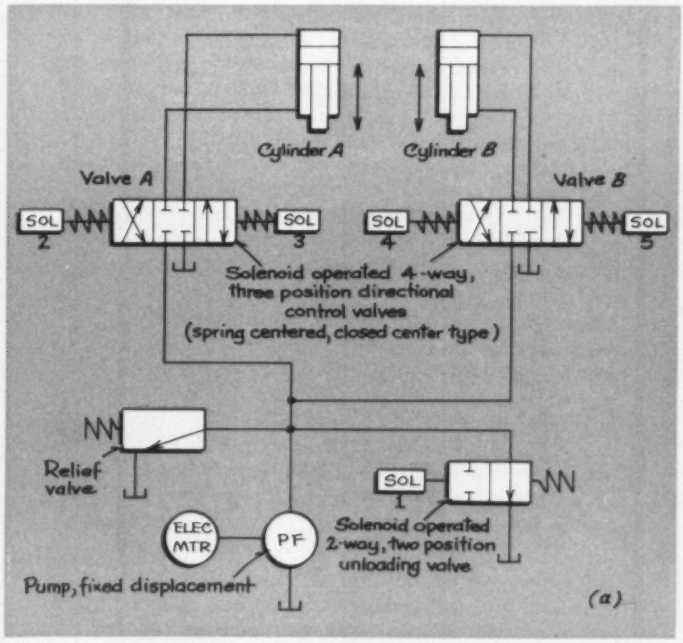
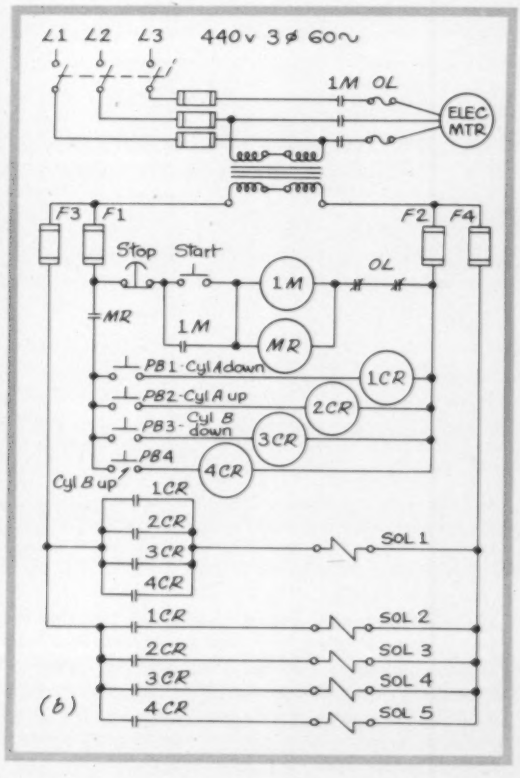


Fig. 52—Electrically controlled counterpart of purely hydraulic circuit of *Fig.* 51. In this arrangement, electrical pushbuttons energize solenoids through relays to determine cylinder actions and position of unloading valve.



sequence might be: 1. Operate cylinder *A*. 2. Hold valve *A* over. 3. Operate cylinder *B*. 4. Reverse cylinder *B*. 5. Release valve *B* to neutral. 6. Reverse cylinder *A*. 7. Release valve *A* to neutral. Sequences in this order are common for injection molding and diecasting machines. Cylinder *A*, for example, might perform the function of clamping the die, and cylinder *B* could effect feeding of the molten plastic or metal. This system has the limitation for general use that valve *A* must be held over during operation of cylinder *B*.

Pilot Operated Circuits

It is relatively easy to develop pilot operated circuits that have no restriction on simultaneous operations, and which use standard components. *Fig.* 51 illustrates what can be done.

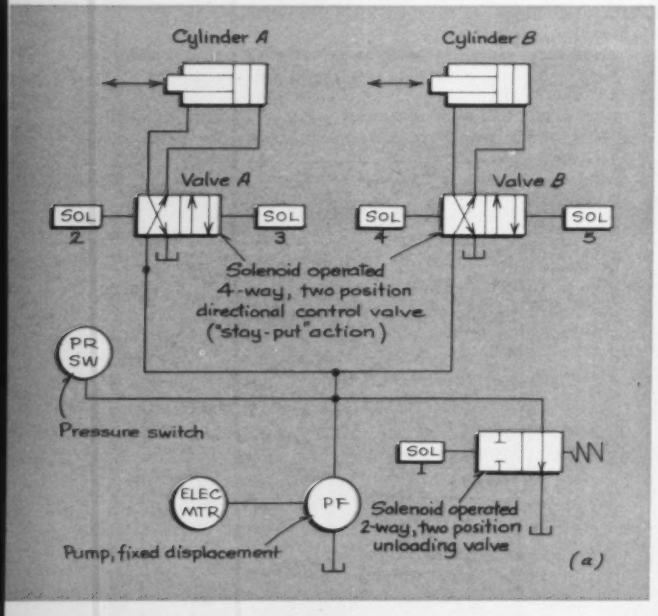
In this circuit, the pump discharges to tank through restrictor *R*2 and unloading valve *V*11. Because of the slight resistance to flow offered by *R*2, a small pressure is developed at the pump outlet connection during unloading. Operation of any one of pilot valves *V*1, *V*2, *V*3, or *V*4 opens a passage so this pressure can act on an appropriate pilot piston of directional control valve *V*5 or *V*6. This same small pressure, acting through one of check valves *V*7, *V*8, *V*9, or *V*10 (depending on which pilot valve was actuated), closes the unloading valve.

It should be noted that the resistance to flow offered by restrictor *R*1 in this branch of the circuit must be high enough not to drain off the pressure needed to keep the unloading valve closed. The function of *R*1 will be described later.

When any pilot of either directional control valve receives pressure, the spool of the valve affected shifts away from neutral, and a cylinder operation ensues. Assuming, for example, that valve *V*4 has been depressed, the righthand pilot of directional control valve *V*6 will be actuated and the piston of cylinder *B* will rise. When *V*4 (in this instance) is released, the pilot of *V*6 drains to tank, and the spool is returned to neutral by the centering springs. At the same time, the pilot of the unloading valve drains to tank through *R*1, and the unloading valve opens. This circuit has the disadvantage that the pilot valves must be held in for the full period of any cylinder operation.

Electrically Operated Circuits

An electrically operated counterpart of the pilot system of *Fig.* 51 is illustrated in *Fig.* 52. In this system, all of the valves are solenoid operated and actuated by pushbutton control. Normally, the



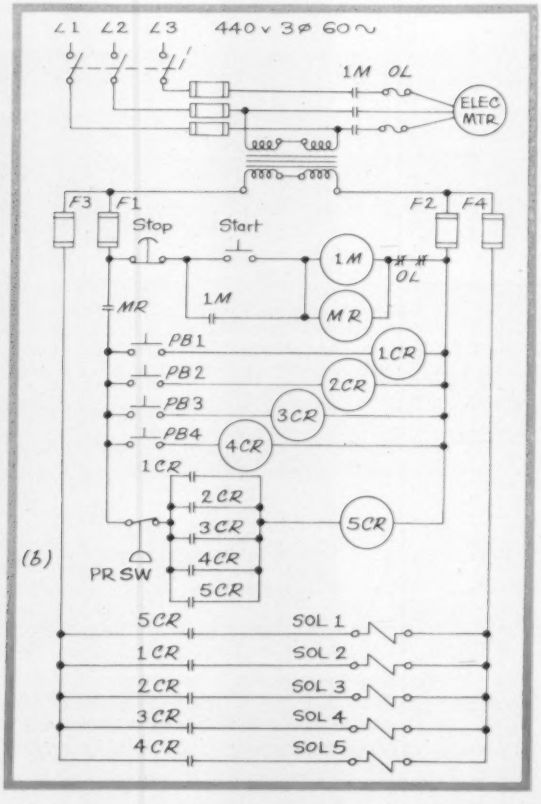


Fig. 53—"Stay-put" action of solenoid actuated directional control valves provides complete piston strokes when pushbutton controls are operated momentarily. Unloading valve is held closed by SOL 1 during piston motion, and opened by de-energization of SOL 1 when pressure switch opens. Initial positions of directional control valves can vary with this circuit.

unloading valve is open, and the directional control valves are spring centered to their neutral positions.

Operation of the system is begun by momentarily depressing the *Start* button, *Fig.* 52(*b*). This causes closing and holding in of relays 1*M* and *MR*. Contacts of relay 1*M* then start and maintain the pump motor in operation; a contact of relay *MR* places voltage across the portion of the control circuit that includes pushbuttons *PB*1, *PB*2, *PB*3, and *PB*4.

Thereafter, depressing any one of these pushbuttons will energize *SOL* 1 to close the unloading valve, and will also energize a solenoid of the directional control valve associated with the particular button depressed. Operation of *PB*2, for example, will close the unloading valve by actuating *SOL* 1, and will also energize *SOL* 3 and shift the spool of valve *A* to the left. This last action causes the piston of cylinder *A* to rise.

This system has the same restriction as the pilot operated system of *Fig.* 51, in that the actuating control must be held in for the full period of piston motion desired. The relief valve in this circuit limits pressure at the ends of cylinder strokes, and protects the pump in the event of failure of the spool of either directional control valve to leave its neutral position.

Systems can readily be devised in which electrical pushbuttons need not be depressed for the full period required to complete an operation. One such system, *Fig.* 53, makes use of "stay-put" type control valves and a pressure switch to effect automatic control. With the pump in operation, momentarily depressing any one of pushbuttons *PB*1, *PB*2, *PB*3, or *PB*4, *Fig.* 53(*b*), will energize and hold *SOL* 1 (the control valve solenoids require only momentary actuation because of the "stay-put" feature). Pressure rise at the ends of cylinder strokes will then open the pressure switch and de-energize *SOL* 1 to unload the pump.

This circuit entails the disadvantage that the initial positions of the control valves are unknown. Even though they might be equipped with indicating means, operator confusion could still occur during complex cycles. Also, uncontrolled movement of cylinders possible during the idling phase requires prevention by separate means.

The electrical control circuit of *Fig.* 54 overcomes this difficulty. Relays and holding contacts have been provided in this circuit to hold energized any solenoid that is initially energized by the momentary actuation of a pushbutton. The hydraulic circuit of *Fig.* 52 can readily be adapted for this type of control by the mere addition of one pressure switch. The function of the pressure switch would be to automatically de-energize the controls and unload the pump when piston strokes are ended.

Purely hydraulic circuits that provide automatic unloading, and do not require full-period actuation by an operator, are also feasible. For example, spring centered, open center valves equipped with mechanical latches might be used—an action such as rise in pressure at the end of an operation could be made to release the latches and allow the valves to center.

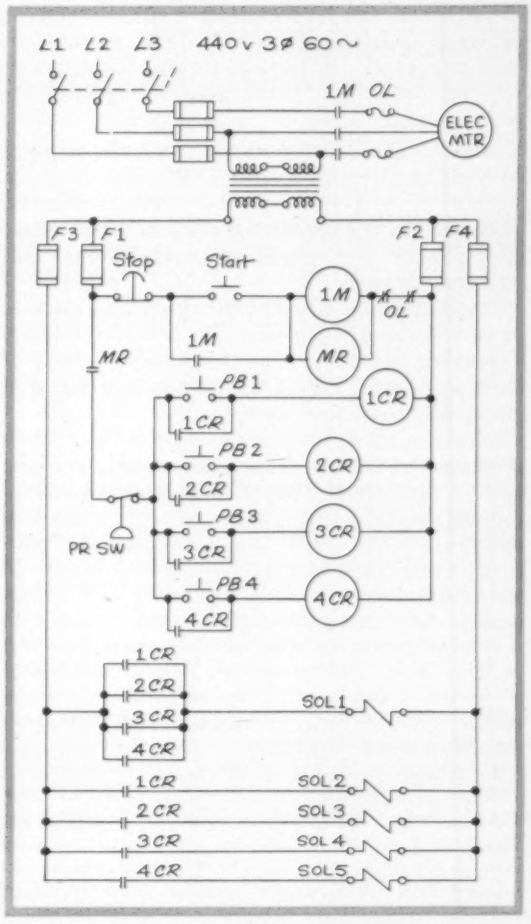


Fig. 54—Addition of one pressure switch to hydraulic circuit of *Fig.* 52 (*a*) enables use of this electrical control circuit. Advantage is that pushbuttons need be depressed only momentarily to effect complete cylinder strokes. Directional control valves are automatically restored to neutral at ends of strokes.

Such valves have been used in aircraft hydraulic systems, but suitable standard components do not appear to be available for industrial use. There seems to be no reason, however, that standard valves could not be modified to operate in this manner.

▶ Selection of Working Pressure

Working pressures have not been standardized for industrial hydraulic systems, nor is there any good reason why they should be. The system designer thus has wide freedom of choice in the matter. A few of the factors that influence proper selection of a given working pressure will be mentioned.

The volume of hydraulic fluid required to perform a given amount of work varies inversely with the pressure chosen. Hence, the sizes of cylinders, accumulators, and tanks may be smaller with higher working pressures.

When the time to perform an operation, or unit

of work, is fixed, flow rates vary with the volumes involved. Also, pressure drops for constant efficiency increase in proportion to the working pressure. There is thus a dual effect tending to allow reductions in sizes of pipes and valves as working pressures are increased.

Decrease in size of cylinders, accumulators, tanks, pipes, and valves brings economies in first cost, space, and weight for these components. Greater ease of assembly—particularly in the forming and fitting of pipes—may also result.

Offsetting these benefits, however, is the position of pumps and motors in the pressure situation. The sizes of these components are roughly proportional to their powers, irrespective of pressure, for constant operating speeds. Their cost per horsepower tends to rise with increasing pressure, owing largely to the higher manufacturing accuracies and design complications imposed by high pressure operation.

Oil compressibility may also assume greater importance with higher pressures. When compression is severe, it can cause hammer effect on release, particularly from large cylinders. It may also cause instability in servo systems.

In systems involving speed control by throttling of flow, including servo systems, the use of high pressures may require use of extremely small orifices. These, in turn, are more susceptible to blocking by dirt, and are usually more difficult and costly to manufacture, than larger orifices. This problem arises more frequently in connection with low power equipment, where throttling may be severe.

There is a widespread but ill-founded belief that the use of high pressure increases the likelihood of system leakage. Actually, most seals which will hold a moderate pressure will hold a higher one as well. The same is true for pipe joints. Seal wear may be increased, but that is usually the only significant adverse effect of higher pressures as regards sealing.

Essentially, the advantages to be gained from the use of higher pressures are a function of the horsepower to be developed. If, for example, the power is fairly low, flow rates and volumes handled will also be small, and gains to be obtained from going to higher pressures are limited.

Hydraulic systems for machine tools are commonly rated to develop pressures of the order of 1000 psi. This figure is ample for most applications except, possibly, some broaching operations. Also, as might be expected, some machine tools do not require that high a maximum pressure, depending on the operations to be performed.

It is difficult to name any horsepower figure above which pressures higher than 1000 psi would show substantial benefits for the average machine tool. It would probably not be less than 1 or 2 horsepower. This is not to rule out use of 1000 psi for applications requiring up to, say, 10 horsepower—while no longer optimum, and perhaps leading to a bulky installation—it can still be used.

Except for large presses, the current limit is about 3000 psi. For pressures higher than this, the choice of equipment is somewhat limited, and the price of suitable components tends to rise appreciably.

Cost of the hydraulic equipment is less often a limiting factor in large presses, considering that hydraulics may be the only feasible way of producing the large forces involved. To hold ram diameters to reasonable sizes, and to overcome possible control difficulties that might result from extremely high flow rates at lower pressures, working pressures of 6000 psi and more are often provided. Also, the control gear may be specially developed for the application.

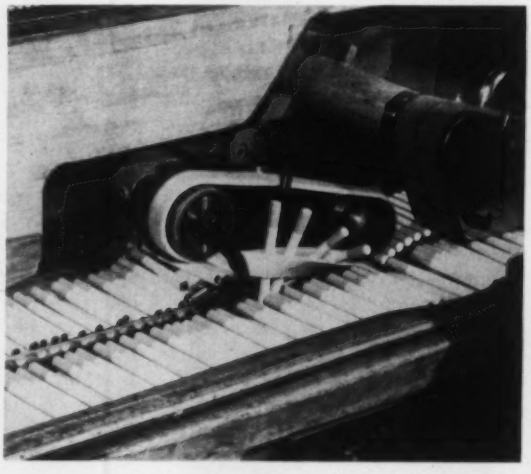
Sixth part of this series, to cover automatic sequencing circuits, will appear in the June issue.

Belt Turnover Device Handles Fragile Product

NOVEL belt turnover device, placed at discharge end of cigarette machines used by R. J. Reynolds Tobacco Co., orients cigarettes for packaging. Previous step in manufacture is to slice double-length cigarettes into two cigarettes at their common filter cartridge.

Fed by two conveyors from the slicer, cigarettes from one conveyor enter the turnover device. Turnover belt is fabric-backed urethane foam in one endless length. Looped over a system of five pulleys in a figure-eight pattern, the belt grips cigarettes and inverts them end-for-end as they are carried to the discharge point. This orients them with their tips in the same direction as the cigarettes not turned end-for-end.

Application suggests use of similar belt arrangements for handling and orienting other fragile items.



INTEGRATED LINE SHAVES AND INSPECTS CLUSTER GEARS

A UNIQUE system that integrates the feed and control functions of four individual gear shaving machines and automatically inspects all finish-shaved gears has been developed and built by National Broach & Machine Co. A system for two-gear clusters is illustrated in *Fig.* 1. Cluster gears are raised by a vertical chain elevator unit to a chute that is pivoted by an air cylinder. The pivoted chute can direct the gears into either of two feed chutes. The feed chutes lead to automatic loaders for the first pair of shaving machines that shave the gears on one end of the cluster.

The position of the pivoted chute is determined by the individual demands of each of the two shaving machines. If the feed chute going to one of the machines is full, or the feed chute for the other machine is nearly out of gears, the pivoted chute is diverted automatically to feed the proper machine. The gears are fed one-at-a-time by rocker-type loaders. They are automatically positioned, shaved, and unloaded into chutes to washers. From the washers they go to motorized gear checkers where they are meshed with double-pivoted master gears and gaged for size accuracy. Gears that do not pass inspection drop from the chutes into pans under the checkers.

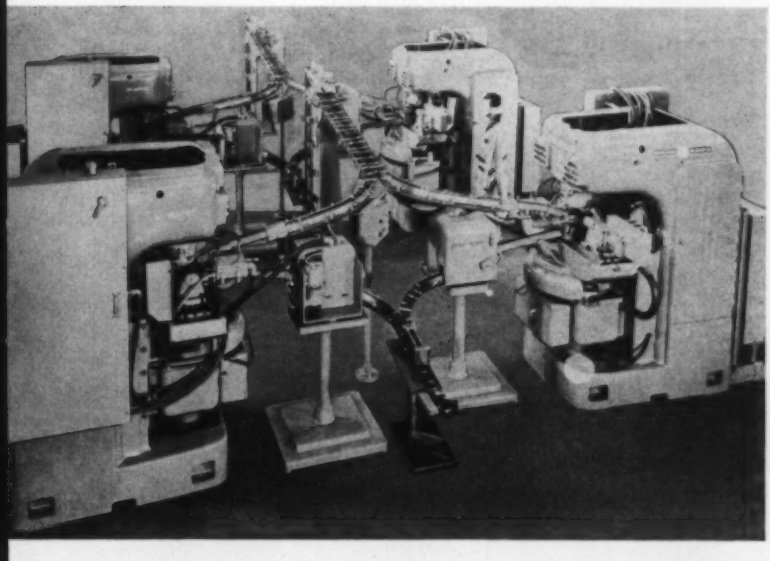
Gears that pass inspection roll around curves into the buckets of a second vertical chain elevator. They are turned end-for-end so that the second gears on the clusters will be positioned correctly for their shaving operation.

Gears from the second vertical chain elevator are fed to another pivoted chute that directs them through inclined chutes into the loaders of a second pair of gear shavers in the same manner as for the first pair of machines. The second gears on the clusters are shaved, washed, and gaged as before. Gears that pass inspection roll down curved chutes where they are lowered to a common chute by a "teeter-totter" mechanism and are fed to the next operation. Rejected gears drop into pans under the checkers.

The automatic gages can be arranged to shut down individual shaving machines after a predetermined number of rejects has been produced. The feed chute for a machine so stopped will start to fill up. When this chute is full, feeding of all gears will be shifted automatically to the alternate machine, thus enabling departmental output to continue. The machine that is shut down can then be serviced for tool change or maintenance.

Individual pushbutton controls are provided for each machine, gage, and chain conveyor, thus enabling each of the units to operate separately and independently for setup or emergency purposes.

If a third gear is included on a cluster, the system can be altered for this shaving requirement by adding another pair of shaving machines, chutes, a vertical chain elevator, and a pair of automatic gear checkers.



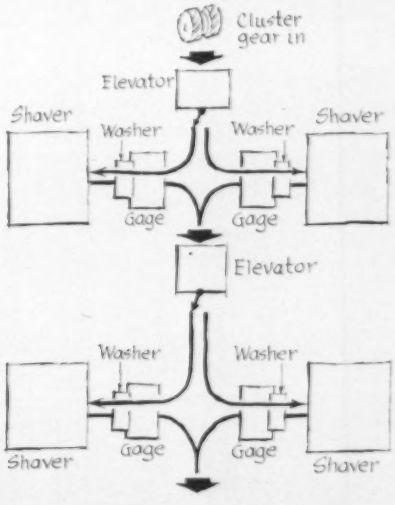


Fig. 1—Over-all view and block diagram illustrate integrated system for automatically feeding, shaving, washing, and inspecting cluster gears.

SIZE CONTROL REPLACES TIMER

FINE FINISHING of cylindrical surfaces is accomplished in the metalworking industry by rotating the work between centers or in a collet and bringing an abrasive stone into contact with the surface to be finished. The finishing action is usually carried out in two steps—roughing and final finishing—and the duration of each step is established by a timer. In such an arrangement, the final size of the finished part is determined by the size of the ground part before finishing. Tolerances on a preceding grinding operation must thus be held to those desired on the finished part.

At Superior Steel Products Corp., guide pins for die sets are being finished on a Superfinisher built by Gisholt Machine Co. and equipped with an in-process air gage supplied by Sheffield Corp. In this production setup, *Fig.* 1, the length of the roughing cycle is controlled by the air gage. The roughing cycle is continued until the workpiece reaches a preset size; then the final finishing cycle is begun and lasts for a timed interval. Using this control arrangement, it is no longer necessary to require finished part tolerances in the preceding grinding operation. Instead, parts are ground 0.0002 to 0.0012 inch above mean dimension, then finished to produce a controlled surface finish of 2 to 3 microinches and part sizes within 0.0002 inch of each other.

Operation of the size-controlled finisher is simple. The operator places the work between centers and pushes a button to start the cycle. As the stone quill descends, the size control head is raised under the part to operating position. The head is a U-shaped device with an adjustable air jet cartridge in each arm of the "U." The cartridges are set 0.0015 inch from the surface of the work, which rotates between them without touching them. The size control head keeps the spindle rotating at a slow speed for a roughing cycle until a preset dimension is reached. At that time, the size control actuates a relay which increases the spindle speed for the timed final finishing cycle. At the end of the cycle, the quill moves up and the size control head descends to clear the part for unloading.

If a part comes to the machine "on size" or undersize, the spindle will go directly into high speed after the cycle is started, and will operate until the finishing portion of the cycle times out. Size is controlled at one point only in this arrangement. If more than one diameter is to be controlled, a size control unit must be used on each diameter. An extra two-position switch on the standard machine control panel permits operation with or without the automatic size control. With the switch in the *Timed* position, separate timers control the roughing and final finishing cycles. With the switch in *Size* position, the size control head replaces the roughing timer in controlling the roughing cycle.

This setup will finish guide pins ranging from 6 to 18 inches in length and from ¾ to 2½ inches in diameter. Guide pins 8 inches long and 1½ inch in diameter are finished in 50 seconds, floor to floor time.

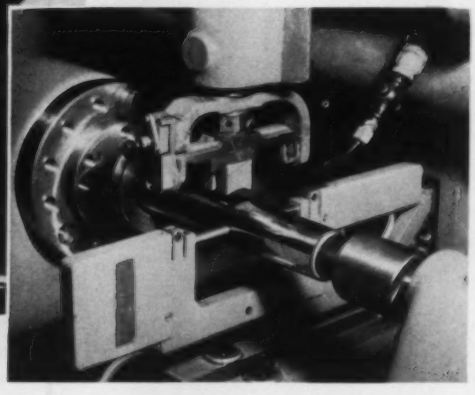
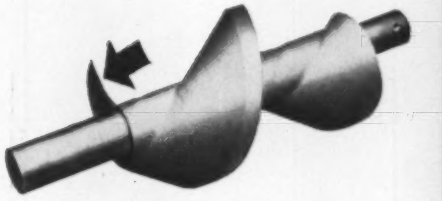
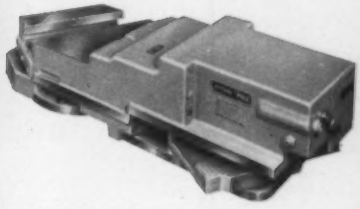


Fig. 1—Semiautomatic setup finishes hardened and ground die-set guide pins, holding size within 0.0002 inch. Duration of the roughing cycle is automatically controlled by an in-process air gage. Final high speed finishing cycle is controlled by a timer. Over-all machine cycle produces finish of 2 to 3 microinches.

New turning idea is born...

LeBlond Engineers turn trick with tracer

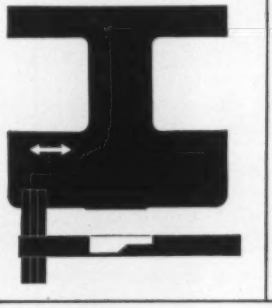


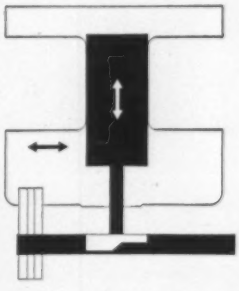


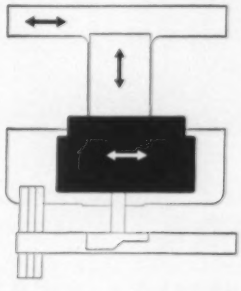
1. Problem workpiece—spiral rotor for pumps manufactured by Roots-Connersville Blower Co., Connersville, Indiana. Shaping just couldn't produce the wide variety of exact contours their engineers wanted. Could rotors be *turned*—automatically?

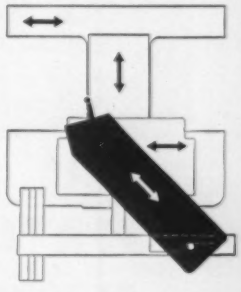
2. Why not? With special end gearing and full nut, we can "chase" the spiral shape like a coarse thread. That's easy . . . the problem is the contour.

3. We'll use Hydra-Trace to *position* the tool (not to trace). We can mount a special length slide on the cross slide to give us feed *between* cuts.







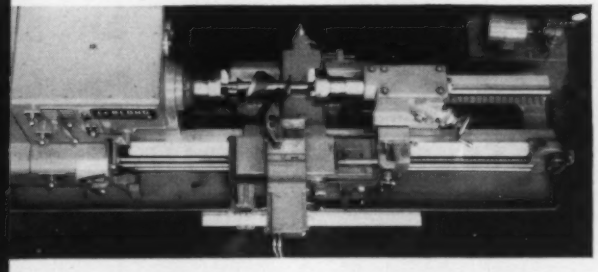


4. Let's see how this looks in plan. The carriage provides length motion for the tool. The template carrier moves lengthwise with the carriage.

5. The cross slide gives cross travel plus automatic tool relief. The template carrier also moves "in and out" with the cross slide.

6. The special length slide gives us feed. Not continuous feed. Just tool-positioning feed that moves the stylus along the template for each successive cut.

7. The template controlled Hydra-Trace positions the tool to produce the contour. During the cut, no feed takes place. Only the chasing action.



8. Here's the finished machine—the LeBlond Contour Chasing Lathe, basically a 32″ Standard Duty. Modifications include: special end gearing, full nut, special length slide, automatic cycling and special heavy duty reversing electrics. Lathe chases leads from 4½″ to 16″.

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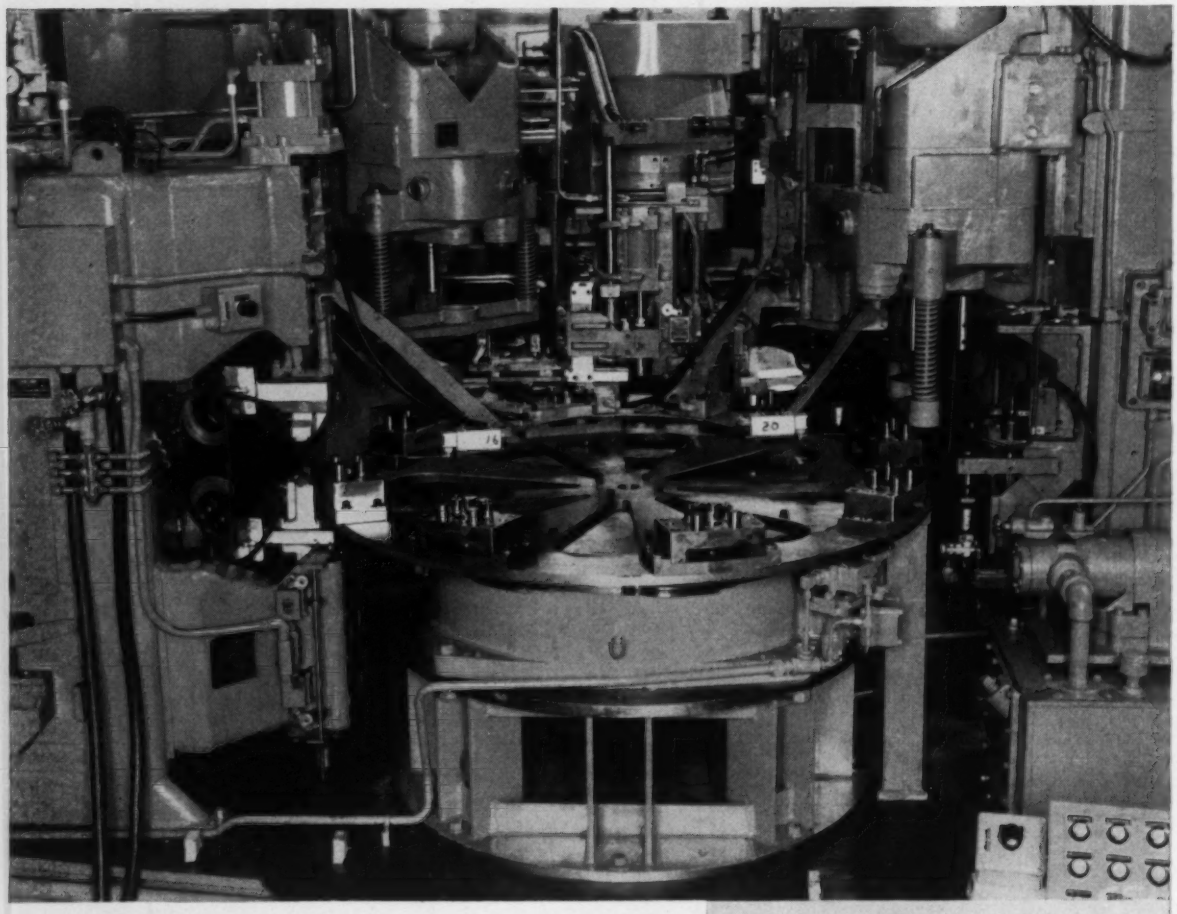
Circle 684 on Page 163



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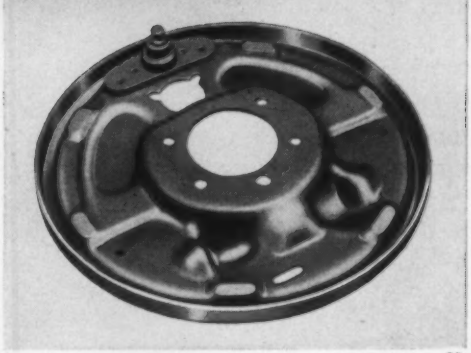

52

Loading, resistance welding, hydraulic reaming, hopper feeding, pressing, hot upsetting and hollow milling are the seven operations—performed automatically—on automotive brake backing plates by this one National Electric Dial Feed Machine. The installation of this unit, by an automobile manufacturer, not only released eight machines for other production, but saved a corresponding amount of floor space as well.

This is only one example of the money and man-hour savings realized when National Electric Automatic Welding Machines are employed. National Resistance Welders, Gas-shielded Arc Welders and Submerged Arc Welders . . . meet the high-speed assembly-line methods and close tolerances demanded throughout American Industry. A National Electric Welding Machine can be developed to fill requirements of any volume welding job. Write today for information.

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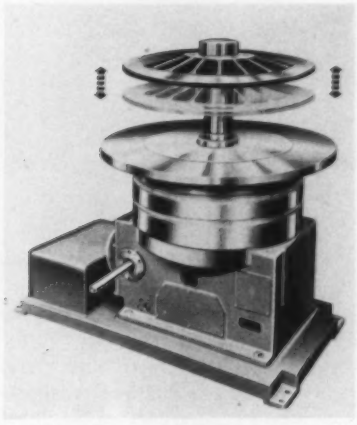
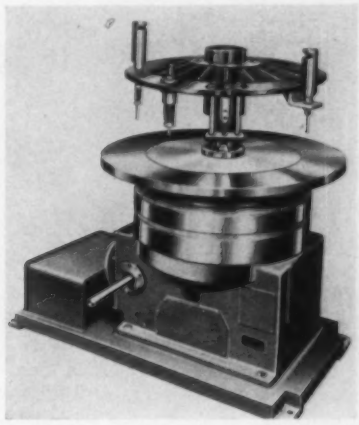
Circle 685 on Page 163

AUTOMATION new equipment

Machines and plant equipment for more automatic operations

For detailed information and literature, use card page 163.





Indexing Machine Chassis Features Auxiliary Motions

VERSATILE rotary indexing machine can be equipped with optional tool-mounting plates for vertical or radial mounting of drills, screwdrivers, punches, assembling devices, etc.

Built by **Swanson-Erie Corp.**, 814 East 8th St., Erie, Pa., chassis is suitable as a basic unit for fabrication of special purpose, multifunction production and assembly machines. Completely tooled mounting plates may be kept in stock or quickly made up as production warrants. Standard or special tooling may be used.

Indexing of the machine is entirely mechanical. It works in conjunction with a locking device that positively positions the turret during each dwell period. Standard units have from 6 to 32 indexing positions in seven ranges, and turret diameters of 36, 42, 48, and 54 inches.

Vertical Tooling

An overhead tool-mounting plate (shown) is available that moves up and down on a center post, completing one vertical cycle for each indexing cycle of the turret. Vertical motion occurs during the dwell period of the turret; while the turret is indexing, the mounting plate is held stationary at the top of its stroke. Rates of speed upward and downward are controlled by a lift cam or crank tied in with the main indexing camshaft. Any desired rise and fall characteristics can be provided; for example, rapid rise and slow descent with predetermined acceleration and deceleration.

Radial Tooling

The center portion of the indexing unit can be equipped with a stationary center plate. Tooling which faces outward may be mounted on the center plate (on slides, if necessary), to operate in conjunction with work-holding fixtures mounted on the indexing turret. A vertical, rotating shaft, projecting through the stationary center plate, can be used to provide actuating force for the radial tooling. By making one revolution for each turret-indexing cycle, the vertical shaft can advance and retract the tools at predetermined rates established by cams.

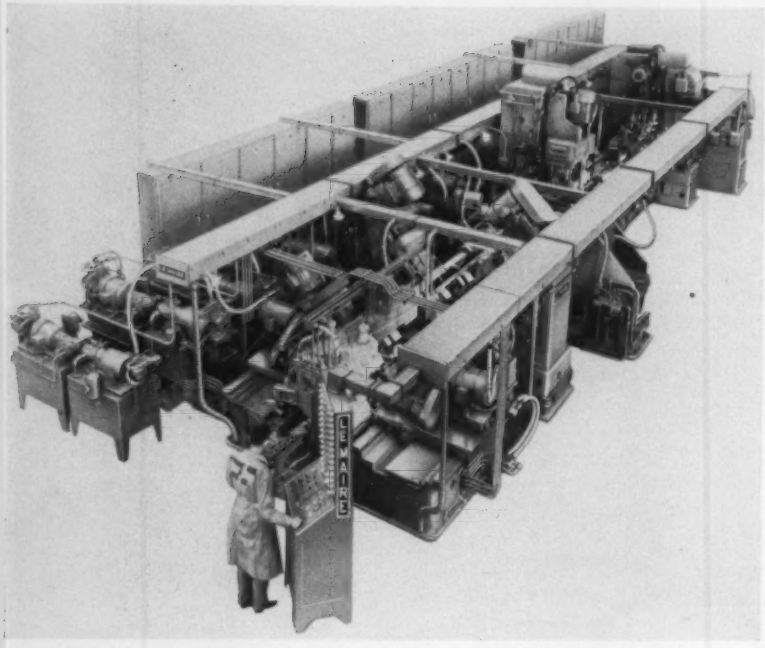
Circle 401 on Page 163

Transfer Machine

Item 402

Transfer machine has 25 stations, can completely machine V-8 engine intake manifolds at the rate of 65 per hour. It can accommodate two different size manifolds for a two-barrel carburetor along with a four-barrel manifold. Designed for transfer-through operation, equipment has automatic loading and clamping at each work station.

In operation, as a part is loaded into Station 1, an electrical interlock actuates the transfer bar to pick up parts in process and move them to idle Station 2. At Station 3, locating surfaces for subsequent machining operations are milled on both sides of the casting by inserted blade cutters mounted horizontally on precision spindles. Both mani-



fold faces are milled by angle-mounted cutters on precision spindles at each side of the machine at Station 4. The next two stations are idle, and at Station 7, the manifold mounting holes are drilled, and one hole is reamed for precision locating purposes at subsequent stations.

The next station is idle, and at Station 9 the part is rotated 180 degrees to position it correctly for following operations. The carburetor mounting pad is machined by two inserted blade milling cutters at Station 10, and at the next two stations, the automatic choke tube hole is drilled. Stations 13 and 14 drill and chamfer the carburetor mounting pad holes. Following an idle station, a self-contained hydraulic unit reams the choke tube hole which has previously been drilled at Station 11. The casting is rotated 200 degrees at Station 17, vibrated to remove chips, then repositioned for indexing at Station 18, where the carburetor mounting holes are probed before the next tapping operation. All holes in the carburetor mounting pad are tapped at Station 20, which is followed by an idle station. At the next three stations, the manifold is automatically indexed 90 degrees to drill and tap end holes; it is then returned to position after these operations are completed, and transferred to Station 25 where it is unloaded.

The "building block" type unit features lighting, selector switches, and controls at each work station, *PresTest* lights on the main control console, and sets of red and green lights at certain stations to signal whether the machine is on automatic or manual control. **LeMaire Machine Tool Co.**, 2657 S. Telegraph Rd., Dearborn, Mich.

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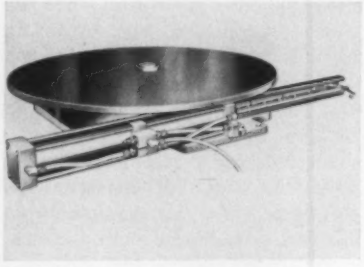

Pneumatic Feed Table

Item 403

Air powered table provides accurate indexing regardless of the weight and size of the objects on the table. Precise positioning is provided by driving a tapered pin, housed in a close fitting guide bushing, into a hardened and ground tapered socket located in the side wall of the turntable. The pin is driven by a powerful toggle linkage energized by a coil spring. The rotative force is supplied by an air cylinder by means of a series of steel links, each riding on six sealed ball bearings, which travels in an arcuate channel concentric with and adjacent to the periphery of the turntable. The chain transmits the power and speed of the ram directly to the turntable by means of a pawl which engages the selected locating port on each working stroke of the ram.

The locking mechanism permits the cylinder ram to retract during the work cycle while the table is locked in place. The turntable remains locked at all times except while the ram is in motion to advance a new station to the work position. Standard unit can index to 4, 6, or 12 stations. It can be mounted vertically and will work at pressures as low as 40 psi. **Mead Specialties Co.**, Dept. TT-P46, 4114 N. Knox Ave., Chicago 41, Ill.

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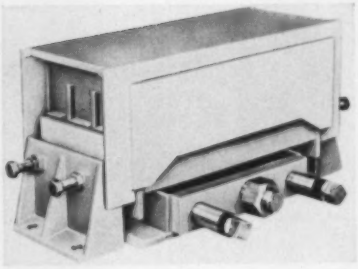
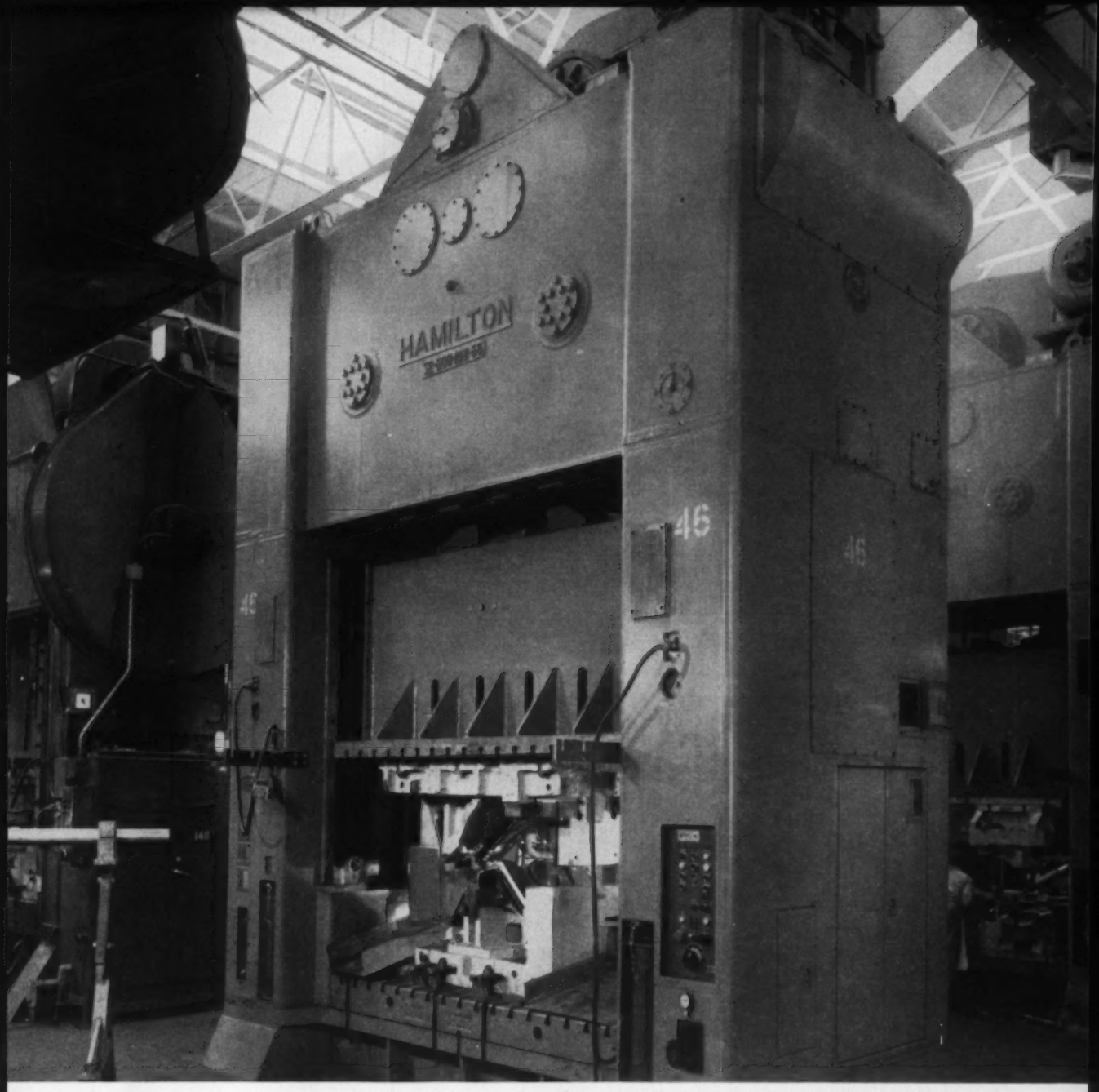


Machinery Mount

Item 404

Base is designed for use with heavy, bulky machinery, and can be adjusted and leveled from the side rather than from the top. Model SW is a vibration, shock, and noise isolator utilizing steel springs as the isolation medium. Flat-top design allows the equipment to be placed in any position under a machine base to provide maximum support of the base. Side access to the adjusting bolts allows quick, easy leveling.

The upper and lower members of the housing are held in their relative positions against lateral movement by resilient chocks which take up any horizontal thrust and which can be adjusted for varying degrees of damping to limit vertical and horizontal oscillation under both vibration and shock. Base is available in 7 load carrying ca-



This versatile 600-ton Hamilton Eccentric Gear Press is currently turning out a wide variety of parts in a major automobile plant in Detroit.

Why an eccentric gear press?

Hamilton Eccentric Gear Presses are ideally suited for heavy duty operations—particularly deep draws and other stamping operations where the tonnage is encountered well up on the stroke.

The eccentric and gear are integral and rotate on a short eccentric pin, as a result of which torsional and bending loads are negligible.

The many added features of Hamilton Eccentric Gear Presses guarantee greater production, improved stamping quality, and lower maintenance costs.

Write to Dept. 4D for Bulletin #13301, describing these machines

Hamilton Division Hamilton, Ohio

BALDWIN · LIMA · HAMILTON

Diesel engines • Mechanical and hydraulic presses • Can making machinery • Machine tools

BALDWIN BLH LIMA-HAMILTON

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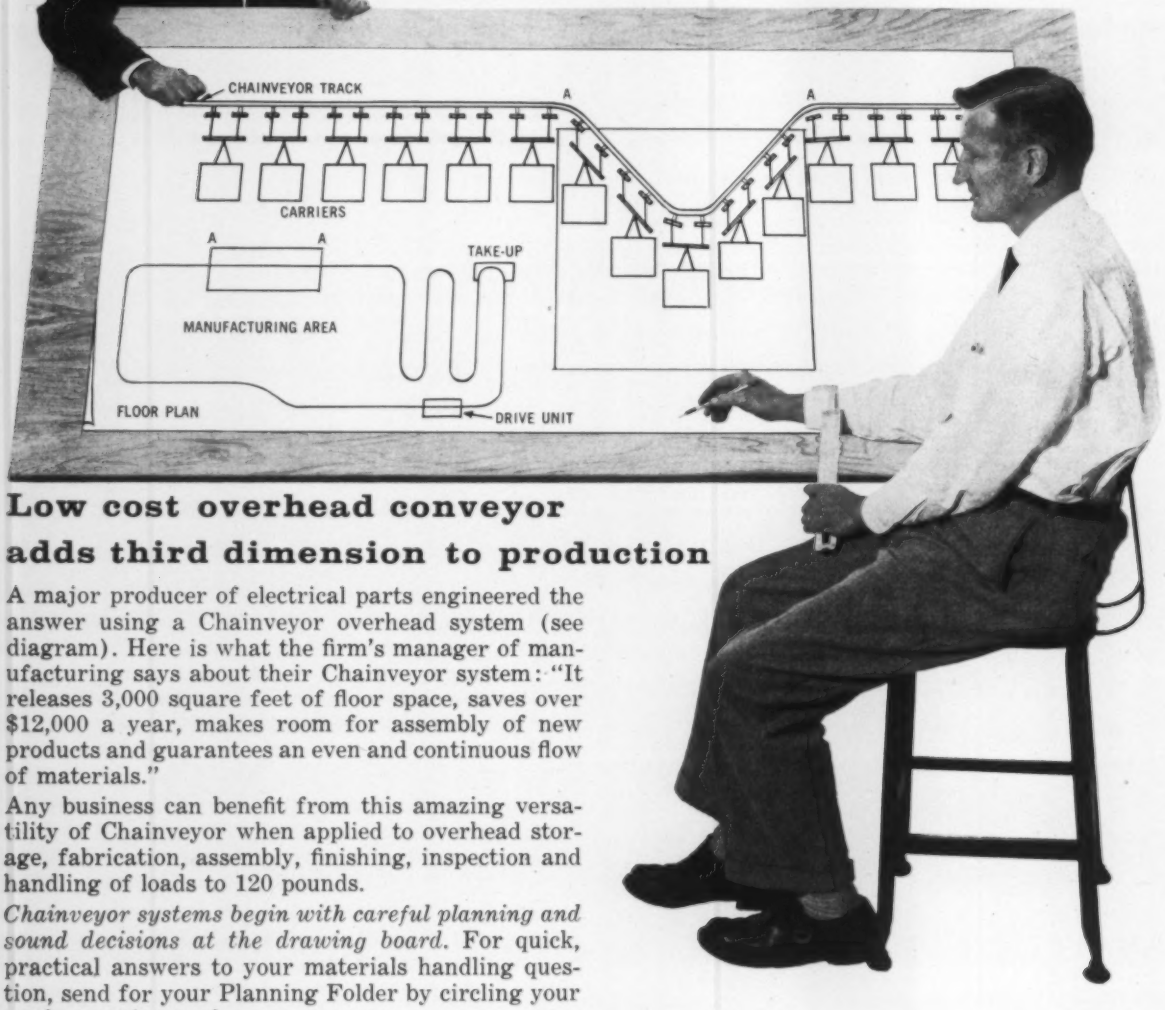
Chainveyor Saves Manufacturer $12,000 on Space Alone!



Low cost overhead conveyor adds third dimension to production

A major producer of electrical parts engineered the answer using a Chainveyor overhead system (see diagram). Here is what the firm's manager of manufacturing says about their Chainveyor system: "It releases 3,000 square feet of floor space, saves over $12,000 a year, makes room for assembly of new products and guarantees an even and continuous flow of materials."

Any business can benefit from this amazing versatility of Chainveyor when applied to overhead storage, fabrication, assembly, finishing, inspection and handling of loads to 120 pounds.

Chainveyor systems begin with careful planning and sound decisions at the drawing board. For quick, practical answers to your materials handling question, send for your Planning Folder by circling your reader service card.

Send for your PLANNING FOLDER

- *A handy file folder for keeping materials handling information.*
- *Special illustrated catalog with proven applications, details and representative users.*
- *Explanatory diagram illustrating a typical Chainveyor layout showing component parts.*
- *Plant and conveyor planning grid sheets for preliminary layouts.*

QUALITY OVERHEAD CONVEYOR SYSTEMS

CHAINVEYOR® CORPORATION

Engineers and Manufacturers

DISTRIBUTORS IN ALL PRINCIPAL CITIES

DISTRICT SALES OFFICES • NEWARK CHICAGO DETROIT NEW ORLEANS

MAIN OFFICE • 5618 E. Washington Blvd., Los Angeles, Calif.

Circle 687 on Page 163

pacities ranging from 38,000 lb to 125,000 lb each. Lengths are from 20 inches to 35 inches, widths from 12 inches to 20 inches. **Korfund Co. Inc.**, 48-8 32nd Place, Long Island City 1, N. Y.

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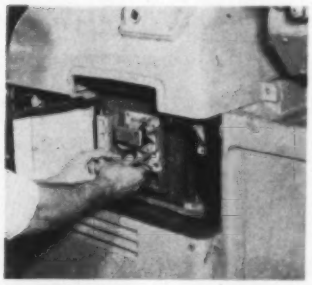

Tape Controlled Lathe

Item 405

Equipment controls all machine motions by means of data on a prepared punched tape. It is designed for use with company's automatic chucking turret lathes. A programming sheet is prepared from data on a blueprint. A tape punching machine punches the holes in the tape, then the two ends of the tape are joined together to form a continuous belt, providing repetitive cycling without rewinding. The programmed tape is then inserted into the machine's tape reader and the unit is set for automatic operation. Starting, stopping, rapid traverse, and speed and feed changes of the spindle, turret, and cross slides are automatically controlled by the tape. **Potter & Johnston Co.**, Pawtucket, R. I.

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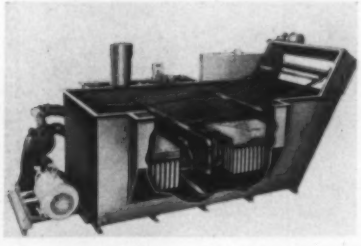

Vacuum Filter

Item 406

Unit provides continuous filtration even while cleaning. Two manifolds are used on an alternate cycling basis. When one manifold is filtering, the other is on backwash for cleaning of the permanent filtering elements. Two forms of filtering elements and two optional types of filtering media are used. The elements are in leaf-type or tubular forms, and the media is available in either nylon or wire screen. The leaf-type element permits immediate removal of the individual elements for inspection or maintenance. The form of the elements and the media used depends on existing conditions of the specific fluid and the contaminants to be filtered. Flow capacities range from 5 to 1000 gpm; higher capacities are handled through use of multiple units. **Industrial Filtration Co.**, Dept. DM-471, Lebanon, Ind.

Circle 406 on Page 163

Small Parts Packager

Item 407

Packaging machine automatically prints, seals, cuts off, and counts packages up to 8 inches by 8 inches, in a continuous uninterrupted flow. Small mechanical parts can be packed individually or in multiples at speeds up to 6000 bags an hour. Coated or laminated heat sealable packaging materials are suitable. An electronic thermistor control holds temperatures to approximately ± 1F on heat sealing rollers. Machine is equipped with an upper and lower rotary turntable feed; a Syntron vibrator feed; quick-change sealing sleeves which simplify the changing of bag sizes; a rubber plate, Addressograph plate, or Markem printer; adjustable speed motor; an electric reset bag counter; and an automatic empty bag ejector. A safety cutoff device overrides when any object gets in the way of cutoff blades. **Product Packaging Engineering**, 5747 Marilyn Ave., Culver City, Calif.

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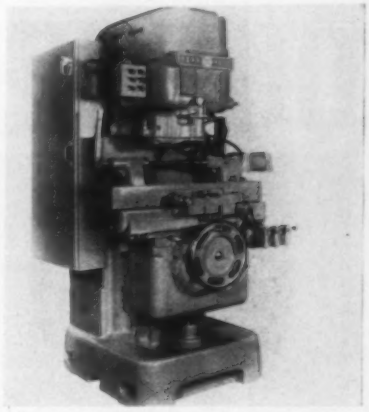

Gear Honer

Item 408

Adaptable for manual, semiautomatic, or fully automatic loading, gear honing machine provides two different methods for honing hardened gear teeth. The headstock and air-powered tailstock are mounted on a tilting table which is attached to the reciprocating worktable through a hinged mechanism at the rear. A constant-pressure arrangement provided by the tilting table removes nicks and burrs and improves the surface of hardened gears. When a constant-pressure air valve is actuated, the work is brought into tight-mesh contact with the abrasive-impregnated, gear-shaped plastic honing tool. An air cylinder controls and maintains the pressure condition between the work gear and honing tool during the operation.

For hardened gears requiring more tooth shape correction, a zero—backlash tilting table arrangement can be used. With this method, the work is tilted into tight mesh under controlled loading conditions by an air cylinder, and locked in that fixed position by a locking air cylinder. The work is then honed in fixed center-distance relationship with the honing tool. At the end of the honing cycle, the locking cylinder is released and the table tilted down to permit removal of the finish-honed gear. **National Broach and Machine Co.**, 5600 St. Jean Ave., Detroit 13, Mich.

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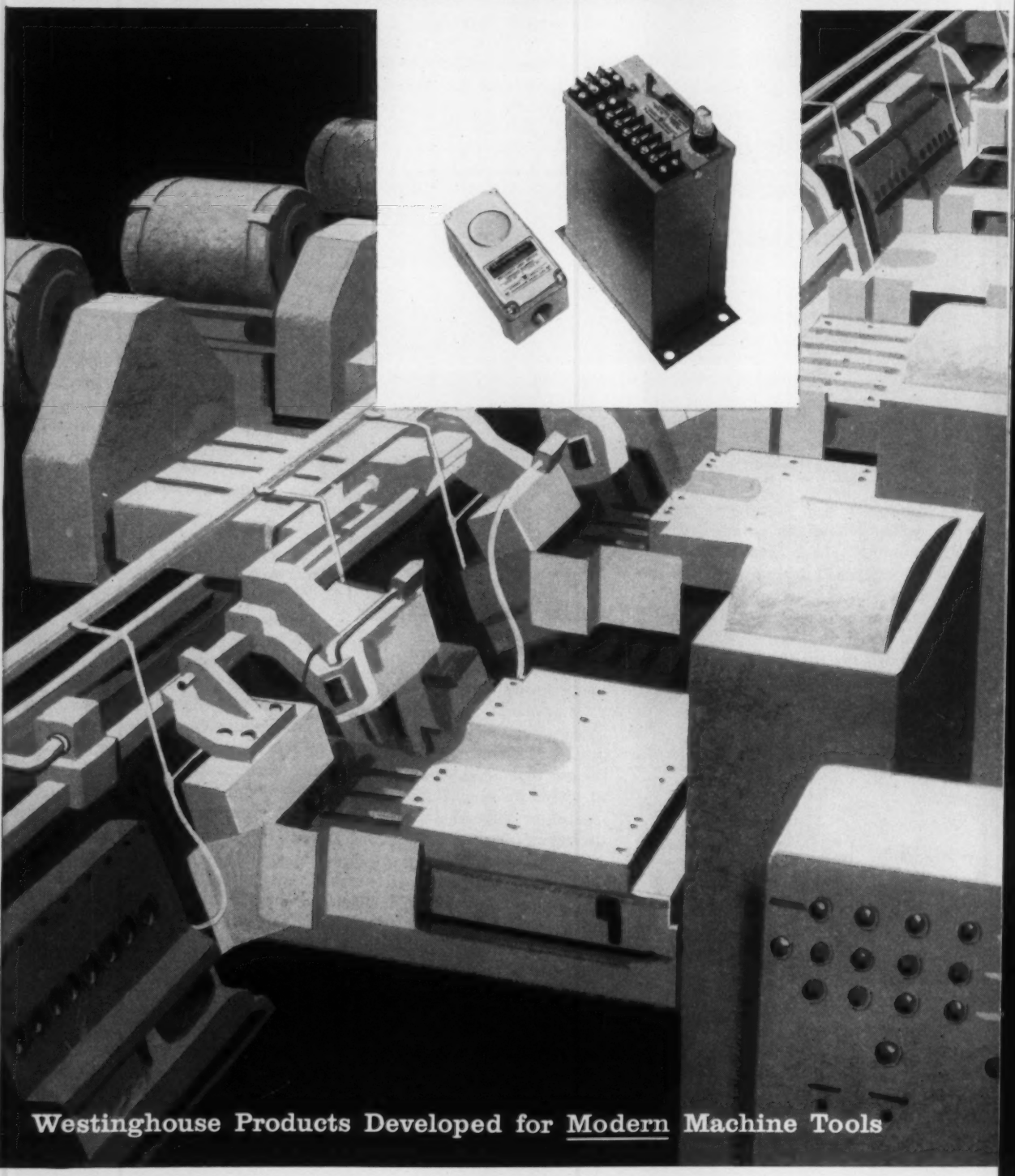
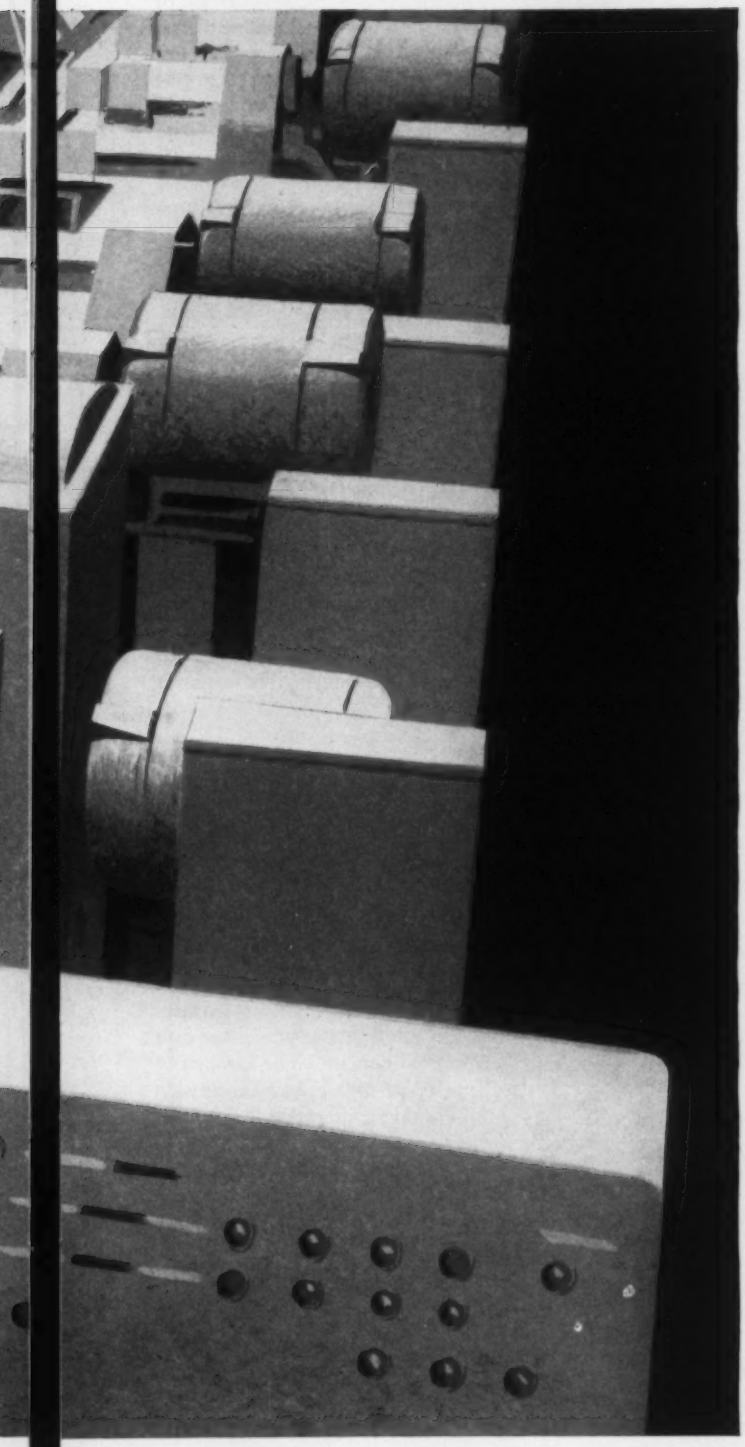
NEW PROXIMITY LIMIT OUTLIVE THE MACHINE IT



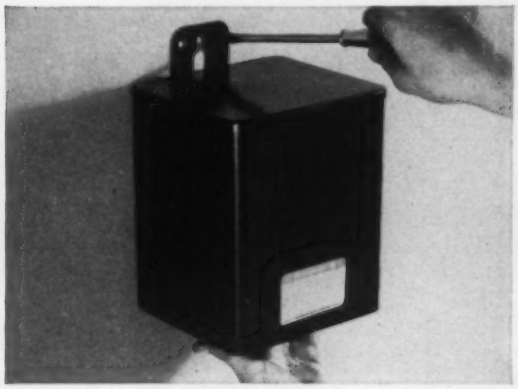
SWITCH WILL CONTROLS



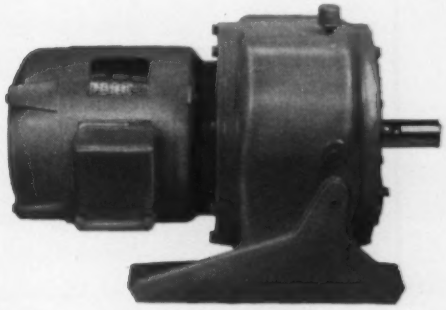
With the elimination of conventional mechanical parts, the new Westinghouse Proximity Limit Switch is the final link in a truly reliable control system. Developed and designed through practical research in Westinghouse engineering facilities, this new product is suitable for a wide range of application in the machine tool industry.

Westinghouse products like this are the sign of a modern machine tool, designed to give the most production at the lowest possible cost. An electrical system, designed and supplied by Westinghouse industry-experienced engineers, is sure to give the best in long-term economical service.

For complete information about Proximity Limit Switches and the other Westinghouse components for modern machine tool systems, ask your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-96110



Westinghouse EP Machine Tool Transformers cut space requirements up to 50%, can be mounted in any position. Accelerated life tests indicate new design doubles normal machine tool transformer life.

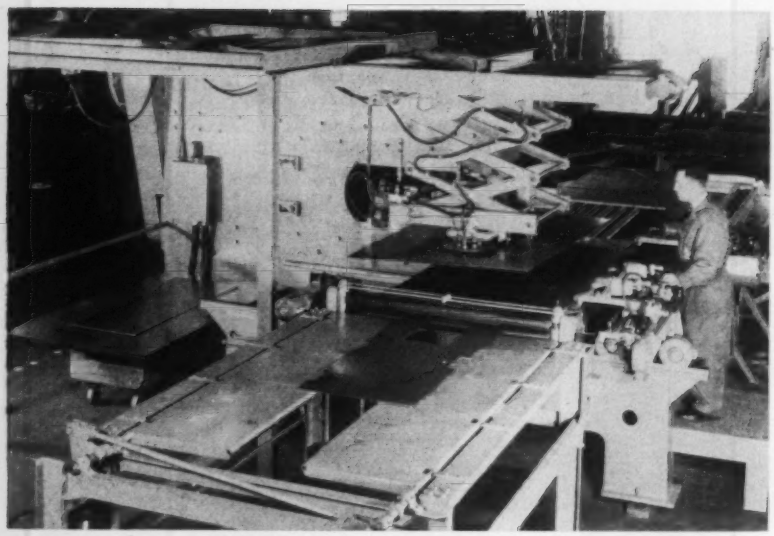


New Moduline Gear Units use 15 basic subassemblies to standardize over 20,000 gearing configurations. One wrench modifies any unit. Gears meet AGMA "master-gear" standards for quiet, maintenance-free operation.

YOU CAN BE SURE...IF IT'S

Westinghouse

Circle 688 on Page 163



Metal Sheet and Plate Handler

Item 409

Unit is designed primarily to load and unload large metal sheets or plates into and out of company's turret punch presses. In operation, metal to be punched is picked up from a stack at the rear of the press by a pair of 14-inch diameter vacuum cups, operated by an automatically controled vacuum pump. The workpiece is automatically brought to the front of the press and placed on the table. It is then secured to a movable cross slide with air-operated work holders. During the piercing operation, the loading unit returns to the stack to pick up the next workpiece. After the first piece is pierced, the operator releases it by means of a pushbutton. The workpiece is then moved onto the stacker by power rollers while the loader places the next piece on the table. Model shown is capable of loading and unloading metal up to 48 inches by 84 inches, and up to 400 lb. Unit is also available in different sizes for use with shears and other fabricating equipment. **Wiedemann Machine Co.**, 634 Wissahickon Ave., Philadelphia 32, Pa.

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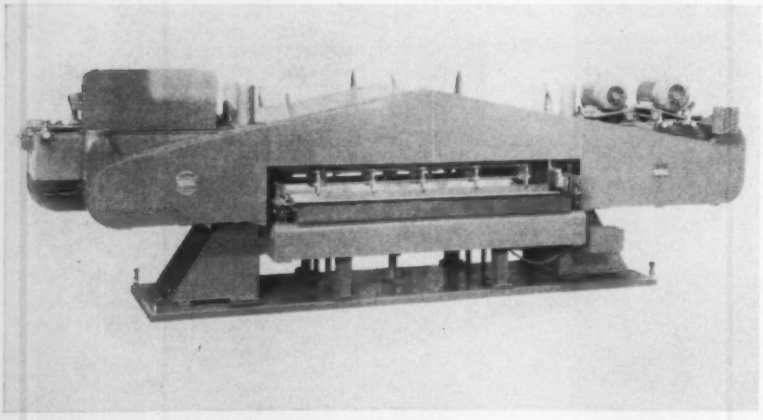

Continuous-Belt Sanding Machine

Item 410

Using the flat belt polishing principle, machine is capable of providing a long scratch pattern on wood panel products. Abrasive heads of the unit incorporate an air-actuated platen, a contact pad belt and a sanding belt. A series of pads at intervals along the contact pad belt create sanding pressures across the entire length of the panel. The pads, traveling at 1000 sfpm on the back of the abrasive belt, which travels at 5000 sfpm, simulate the action of a stroking hand block or traveling head.

The machine automatically gages the width of each panel and can sand various size panels as they are intermittently fed through the machine. The platen comes down to initiate sanding pressure when the leading edge of a panel is halfway under the belt. The platen stays down for the period of time that the panel is under the belt and automatically raises when the trailing edge is halfway out from under the belt, regardless of width and feeding speed. This action of the platen eliminates any possibility of dubbing or rounding of the leading or trailing edges.

Two types of polishers are available; Model 1000-A-DB (shown) has a 30 inch minimum width, is designed primarily for plywood and wallboard, has a double belt roll feed polisher that incorporates powered pinch rolls for feeding sheets or panels through a two-grit sequence. Model 1000-C-DB is a conveyorized version, capable of handling stock as narrow as 1 inch wide, is designed for use in the furniture industry. **Curtis Machine Div., Carborundum Co.**, Jamestown, N. Y.

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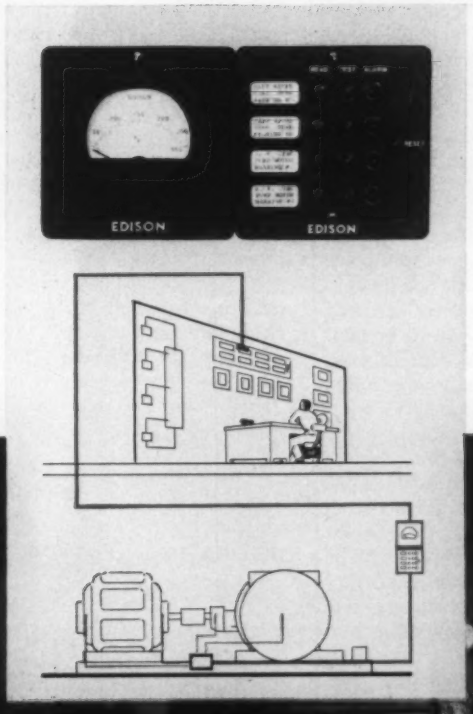
Automatic Stamping Press

Item 411

Automatic stamping press features a large guiding surface area and precision alignment. The low center of gravity permits high cycling with a minimum of vibration. The underdrive mechanism in the base pulls the head down, eliminating overhead thrust. Head rod guides are mounted in large bronze sleeve bearings.

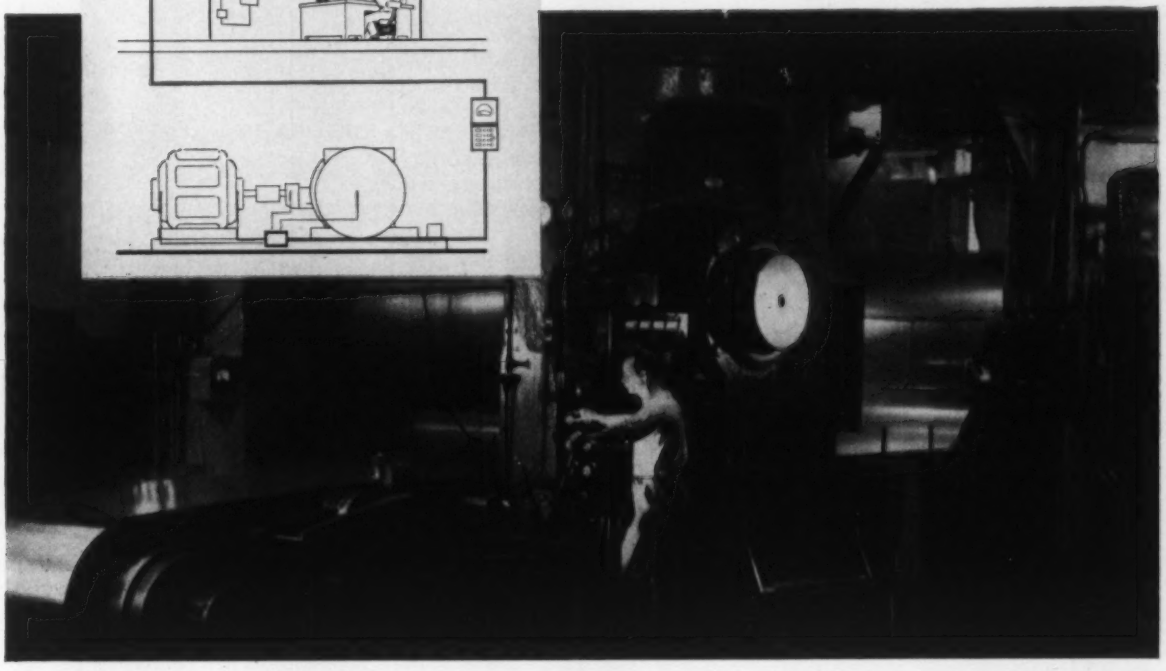
Air-operated pneumatic clutch and multiple disc brake are a single unit. The clutch control permits inching, single stroke, continuous operation and forward and reverse operations. A sheet height adjustment in the head permits accurate



THOMAS A.

EDISON

omniguard system provides low cost temperature monitoring



Edison Omniguard is the simplest and most flexible monitoring system devised for protection against excessive bearing temperatures, gases and liquids. In an Omniguard installation, plug-in monitor units are grouped according to individual requirements—can be added, removed or switched to other equipment without disturbing the system. Individual alarm settings on each point can be changed at any time without special tools.

This kind of flexibility pays off in reducing installation costs by 50% or more . . . permits purchase of minimum number of units needed at any one time . . . and the addition of more points as new equipment is installed.

Other exclusive Omniguard advantages: Single indicator serves multiple points • each circuit is 'on guard' at all times • no moving parts, nothing to wear out • alarm positively identifies trouble point.

Edison Resistance Temperature Detectors coupled with automatic monitors are low cost insurance against loss of production time, equipment replacement and costly repair charges.

Typical Omniguard Panel shows group of monitor units with their alarm lights, test buttons, and temperature read-out switches. Additional units can be installed in a variety of ways to suit your individual needs.

For additional information on the Edison Omniguard, write for Bulletin 3036B.

Thomas A. Edison Industries

INSTRUMENT DIVISION

86 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

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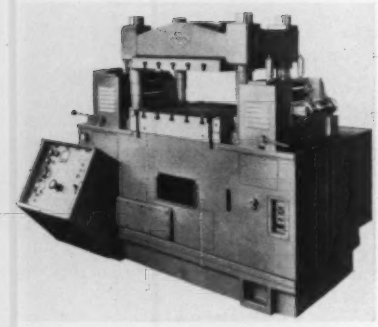

leveling of the upper ram with respect to the bolster plate. Lifting of the feed rolls from contact with the materials is by means of a cam actuated from the lower cross beam. The integral roll feed units are equipped with intermittent brakes and constant drag brakes. This design eliminates overtravel and overheating. The scrap cutter blades are designed with four cutting edges on each blade, providing long tool life. Press is available in four models: 75, 100, 150, and 200 ton capacities. **Alpha Press & Machine Inc.**, 9281 Freeland Ave., Detroit 28, Mich.

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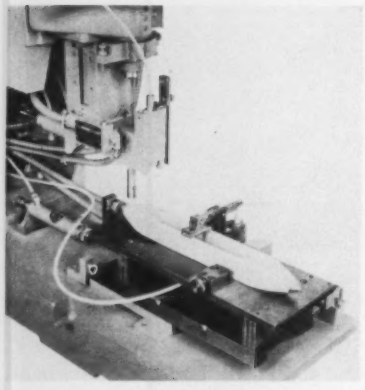

Rollpin Inserter

Item 412

Device feeds and orients workpieces and Rollpin fasteners made by **Elastic Stop Nut Corp.**, Union, N. J., performs the driving operation, and recycles automatically, when used as an attachment to available automatic transfer machine. An air-actuated ram delivers a powerful stroke that can be adjusted for either a push or push-impact drive. The inserter can accommodate single or multiple work nests and perform single or multiple pin insertions. Adjustability of ram head height makes it possible to handle large or bulky workpieces, and a quick-change escapement unit in the adjustable pin feed permits using a full range of pin sizes.

The escapement and feed mechanism includes an escapement unit, punch and holder, feed bowl, and pin feed tube. It feeds all lengths of Rollpins of a given diameter without tooling change; the escapement mechanism is merely adjusted for the length of Rollpin to be run. The adjustable escapement is actuated by an electrically controlled air cylinder for fast feed and return between ram stroks.

In manual feeding, the parts to be assembled are placed in the work nest and a button is pressed. A slide then transfers the work nest to a position under the ram. The slide triggers the escapement, bringing the Rollpin into position. The escapement action triggers the ram stroke, and the Rollpin is driven into the assembly. The ram then retracts, actuating the return stroke of the work nest. The operator removes the finished assembly and reloads the work nest with a new set of workpieces for the next cycle. Where more than one Rollpin is to be inserted at different locations, as along a shaft, a cross slide unit can be provided to enable positioning and driving up to four pins. The unit is available for bench mounting (shown) or it can be supplied with a separate floor stand. **Kenhos Corp.**, 275 Connecticut Ave., Norwalk, Conn.

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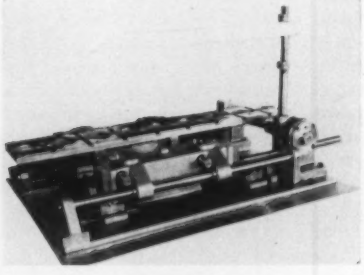

Transfer Unit

Item 413

Mechanical transfer unit is suitable for use between uprights in presses or, where space is limited, on the outside of a press. The unit, which can also be used for press-to-press automation, is completely mechanical, has no electrical, pneumatic or hydraulic actuators. No cams are required, and travel of fingers *in* and *out* and longitudinal travel are adjusted in the press. It is actuated entirely by the movement of the ram. Die changes are quickly made, and the same unit can be converted by replacing the interchangeable bar with new fingers. Device is also adaptable for drilling, tapping, and other machine operations. Two sizes are available for different size presses. **Livernois Engineering Co.**, 25200 Trowbridge, Dearborn, Mich.

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Pressure Logger

Item 414

Automatic digital data logger scans sequentially 24 or 48 air pressure lines feeding into a single transducer. Portable unit has a high-accuracy electronic digitalizer, and visual data display. Output data can be in both punched tape and typewriter form for input to computer or tape-to-card converter. A low switched volume of air results in high-accuracy pressure measurements by minimizing air flow disturbance at probe orifice, and pressure drop at probe orifice and in pressure lines. Controls on the front panel allow scanner reset, calibration, scanning end point, and manual point selection.

Scanning rate is four points per second; accuracy ¼ per cent, repeatability 1/10 per cent. Range is from zero to 350 psi absolute, gage, or differential. **Hanson-Gorrill-Brian Inc.**, 85 Hazel St., Glen Cove, N. Y.

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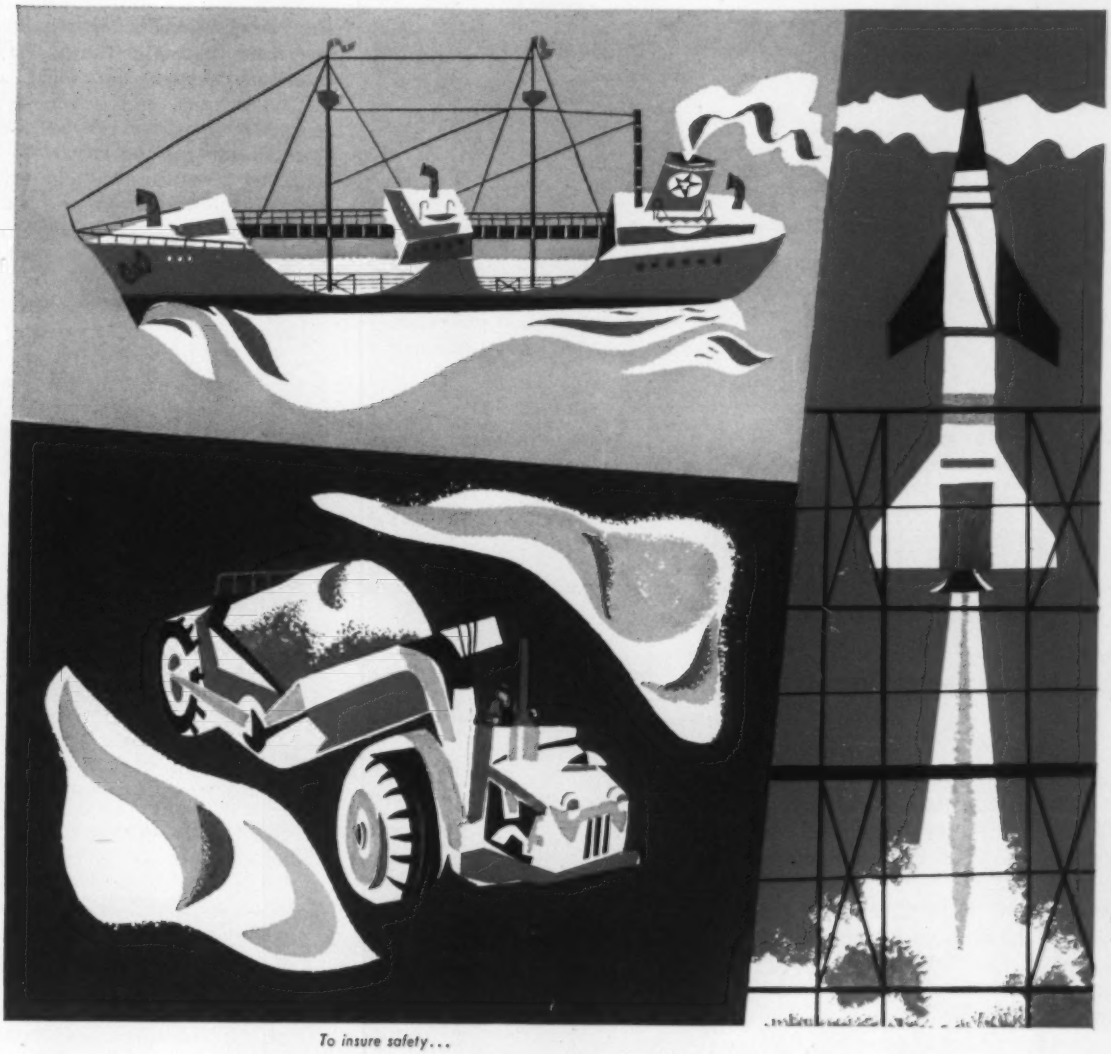
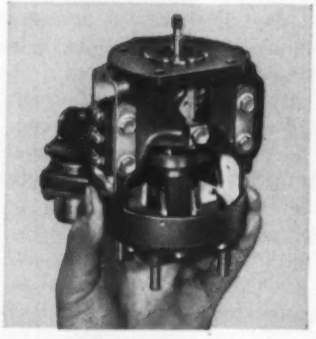


SWITCHES SET OFF BY SPEED!



AC engineers have designed a speed sensing control that is accurate to ½ of 1% at engine speeds ranging from 500 to 4600 rpm. This AC Speed Switch triggers up to four turbine engine functions. It takes the human element of error out of any operation where precise speed sensing is a critical factor.

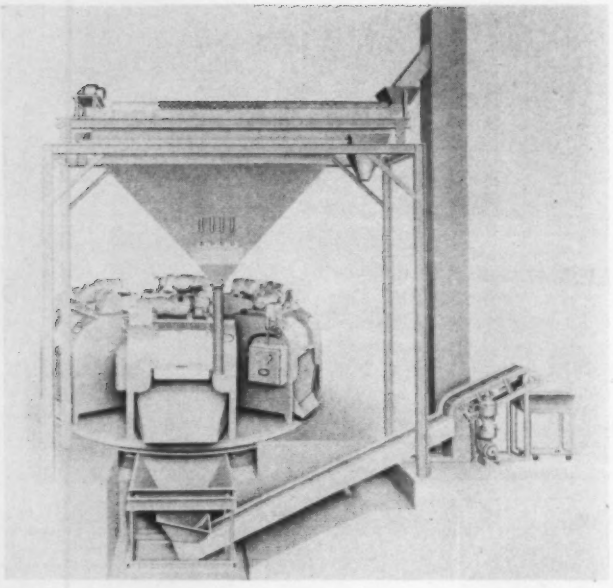
Yet, the AC Speed Sensing Control weighs only about four pounds. It is compact, can be mounted anywhere and can take the roughest kind of treatment. It will withstand high engine vibration without losing calibration . . . functions for long intervals without overhaul.

Call AC-Milwaukee for additional details.

—Or, if you are an electrical or mechanical engineer, and would like to work in Milwaukee, write Mr. Cecil Sundeen, Supervisor of Technical Employment, Dept.K, 1925 E. Kenilworth, Milwaukee 1, Wisconsin.

AC SPARK PLUG ✿ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Producers of: AChiever Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes • Speed Sensitive Switches • Speed Sensors • Torquemeters



Barrel Finishing System

Item 415

Turntable unit automatically rotates completed work to a single operator station for unloading and reloading. All materials needed for precision barrel finishing are available at a single point. The completed work is automatically retured to the work station for rinsing and mechanical separation. As many as ten machines can be mounted on one turntable.

As the operator loads each barrel, an individual timer is set for a prescribed processing cycle. The time cycle also records on a turntable memory device which automatically signals the timed-out barrel and rotates it to the operator's station when the work has been completed. Continuous processing from 15 minutes to 50 hours duration may be programmed.

As each completed barrel load returns to the operator for draining and rinsing, the load of parts and media is fed onto a conveyor belt for transfer to a magnetic separator. The ferrous parts are separated from the media chips by passing up and over a demagnetizing coil. From the coil, parts continue to pick-off tables or wire baskets for removal to assembly or other departments. When both ferrous and nonferrous parts are being processed, a high frequency vibrating screen can be added in the materials handling system for separating parts from media. The media feeds directly into the boot of an internal discharge bucket elevator and is conveyed to the overhead rotary screen media classifier and multicompartment storage bin. **ALMCO, Queen Products Inc.**, Albert Lea, Minn.

Circle 415 on Page 163

Conveyor System

Item 416

System uses one drive, propels articles along a horizontal path, around horizontal curves, up or down any grade desired. Conveyor comes in straight sections, 30, 45, and 90 degree horizontal turns, and 30, 45, 60, and 90 degree vertical turns. The units bolt together to form any required route.

The system consists of a series of small trucks connected by steel linkages into an endless chain. The trucks are guided by full rolling contact in a track and driven by a caterpillar type drive. A steel slider or roller bed for the articles to be conveyed is carried above the track. Pushers extend up from the trucks to engage the articles and positively but gently propel the articles along the bed over any path and at any speed desired. When the entire length of the two runs is not needed, the return run can be directed over a different path from the loaded run and used as an overhead conveyor if needed. **Econ-O-veyor Corp.**, 224 Glen Cove Ave., Glen Cove, N. Y.

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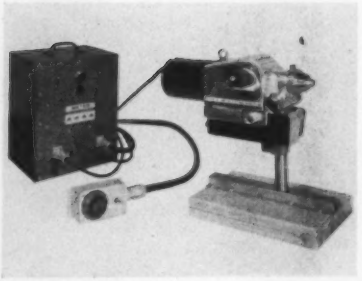

Spray Metallizer

Item 417

Unit can spray any metal available in wire form. It is suitable for use individually, or as a built-in part of a complete automatic setup for large scale production. Driven by electric motor and monitored by an electronic control system, the unit permits adjustment of wire speeds throughout the entire usable range. Once adjusted, the wire speed is held constant regardless of fluctuations in load and operating conditions. A footage counter shows the amount of metal sprayed.

Unit can handle all sizes of metallizing wire up to 3/16-inch diameter, at wire speeds from 9 ipm to 40 fpm. Rotating parts run on pressure-lubricated ball bearings, and the gears are sealed in heavy-duty gear oil. Controls and motor provide high-speed accleration and dynamic braking for responsive *on-off* control of wire feed. The speed control unit can be mounted on the machine or at a remote position. Motor, gear box, and control unit are enclosed and sealed to prevent

damage which might be caused by metal dust. **Metallizing Engineering Co. Inc.**, 1101 Prospect Ave., Westbury, L. I., N. Y.

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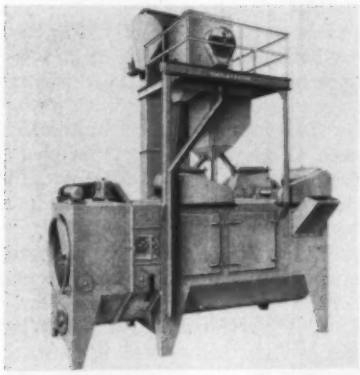

Blast Cleaning Machine

Item 418

Equipment is designed to automatically blast clean a continuous flow of miscellaneous work at a high rate of production. A combination of tumbling and longitudinal travel exposes all surfaces of every part to the abrasive blast of two overhead units. By having the two units blast toward each other a compact design is achieved requiring a minimum of floor space. The location of the blast wheels minimizes the opportunity for the work to catch in them and cause damage to components.

As soon as the cleaned work passes beyond the blast zone it enters into a discharge drum located at the end of the cabinet. The parts are tumbled in this drum to remove abrasive held in cavities or recesses of the work. A variable speed reducer enables the discharge drum to be rotated at the speed most suitable for the type and size of work being cleaned. The work empties into tote boxes or onto a conveyor. The abrasive drains through the perforations in the drum slots and falls into a screw conveyor which carries it to the abrasive elevator. The elevator lifts the abrasive in buckets and dumps it into the separator. It is distributed in a thin curtain over an inclined shed; as it flows off the shed, the abrasive passes through an air current while falling into the storage section. The current of air is drawn through the abrasive curtain,

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Electron Tube Division *Harrison, N. J.*

Circle 690 on Page 163

carrying sand, dirt, and abrasive fines into a settling chamber which empties into a receptacle on the floor. Fine material is carried on to the dust collecting system.

For special production requirements, for use with an existing conveyor system, or when space is limited, an optional front-discharge tumbling drum is available. In this case, the cleaned work drops down an inclined chute from the blast chamber and into the front-discharge drum. **Wheelabrator Corp.**, 1109 S. Byrkit St., Mishawaka, Ind.

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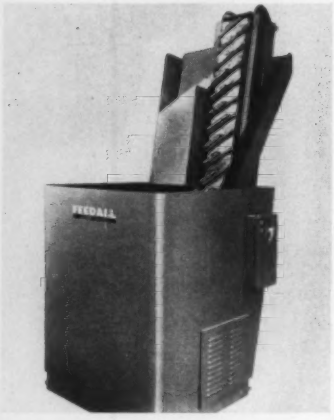

Parts Feeder

Item 419

Machine automatically feeds rolling or sliding parts of various lengths and diameters. The elevating feeder picks up parts from the loading hopper and carries them to the desired feed height on the elevating conveyor and feeds them, properly oriented, into a centerless grinder, milling machine, induction heater, or similar production unit. Model 3000 is a self-contained unit, has a 25 cu ft hopper capacity, is powered by a ¾ hp ball bearing motor. An enclosed baffle box with neoprene-covered plates is provided to minimize damage to recycled parts. **Feedall Inc.**, 38399 Pelton Rd., Willoughby, Ohio.

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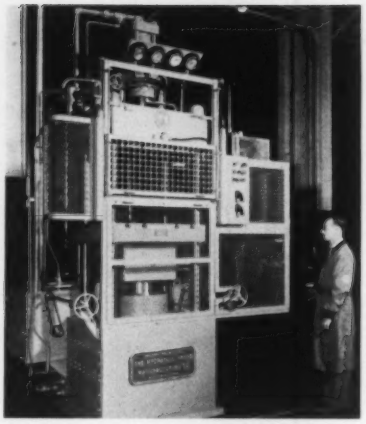
Plastics Molding Press

Item 420

Semiautomatic transfer molding press for plastics features a top-mounted transfer cylinder. The transfer cylinder, located on the



press head, has a maximum force of 25 tons which is adjustable to a minimum of 8 tons. The stroke of the transfer ram is 9 inches. The 12 inch clamp stroke is adjustable to any portion of full stroke. Pressing surfaces for upper grid and platen are 36 by 16 inches. Daylight between platen and head is 30 inches. A 10-ton hydraulic ejector system, built under the moving platen, ejects finished parts. The press is equipped for automatic loading, feeding, and preheating. **Hydraulic Press Mfg. Co., Div., Koehring Co.**, Mt. Gilead, Ohio.

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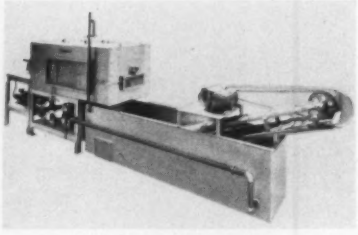

Continuous-Feed Furnace

Item 421

Machine is designed for bright hardening, bright carburizing, bright dry cyaniding, and similar heat treating operations which require temperature to 1900F. Small parts, such as screws, balls, springs, needles, and stampings, as well as large parts can be heat treated in production operations. For bright, nondecarburized hardening and shallow case hardening, an atmosphere generator can be supplied.

In operation, the temperature control and variable speed drive mechanism are adjusted so that all parts are brought to temperature uniformly, and are in the heated zone the required length of time. Multiple zone temperature control provides controllable temperatures throughout the heating chamber. After the controls are adjusted, the work is placed on the hearth plate and later removed from the receiving basket in the quench tank. Furnace provides automatic vibratory conveying of parts through the furnace chamber, thus avoiding the need of reheating a conveyor chain or belt. A Quench-O-Trol unit can be supplied where exacting temperatures must be maintained in the quenching oil. A salt bath quench can be used for martempering or austempering parts. **Hevi-Duty Electric Co.**, 2040 W. Wisconsin Ave., Milwaukee 1, Wis.

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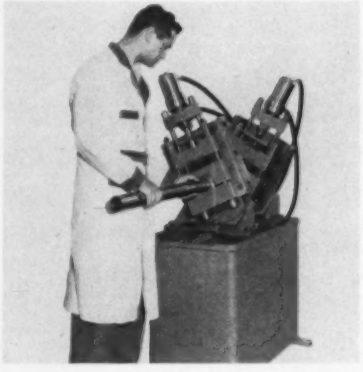

Tube Piercer

Item 422

Machine is designed to pierce round and irregular shaped holes in tubes up to 3 inches in diameter at speeds up to 600 tubes per hour. As the punch engages the work, the tube and mandrel are held rigidly by the action of an upper and lower compression insert. The mandrel remains permanently rigid during the piercing operation. There is no distortion to the tube after release from the mandrel, which automatically releases the tube at the finish. Three standard tubing heads can be mounted on a single base for multiple piercing operations in one loading. Each head can be radially adjusted to 55 degrees either side of the center. **Koppy Tool & Die Co.**, 1530 Farrow Ave., Ferndale 20, Mich.

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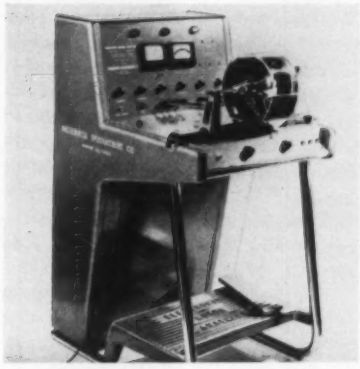

Motor Analyzer

Item 423

Device performs preassembly quality check on electrical components. Electronic analyses are made for opens, shorts, winding errors, reverse connections, hi-pot to ground, and commutator position in electric motors, solenoids, coils, and magnetic materials. Instrument can test six to ten components per minute. Setup time for a given component is less than one minute. Safety features include interlock switches and double operating pushbuttons. Unit is adaptable to analyze magnetic and winding faults on a production basis for a wide variety of electrical components. **Automatic Development Co.**, 2530 N. Naomi St., Burbank, Calif.

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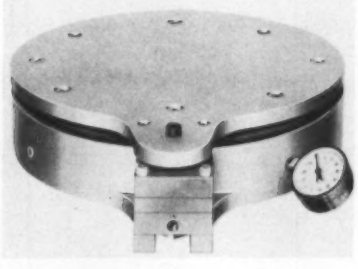


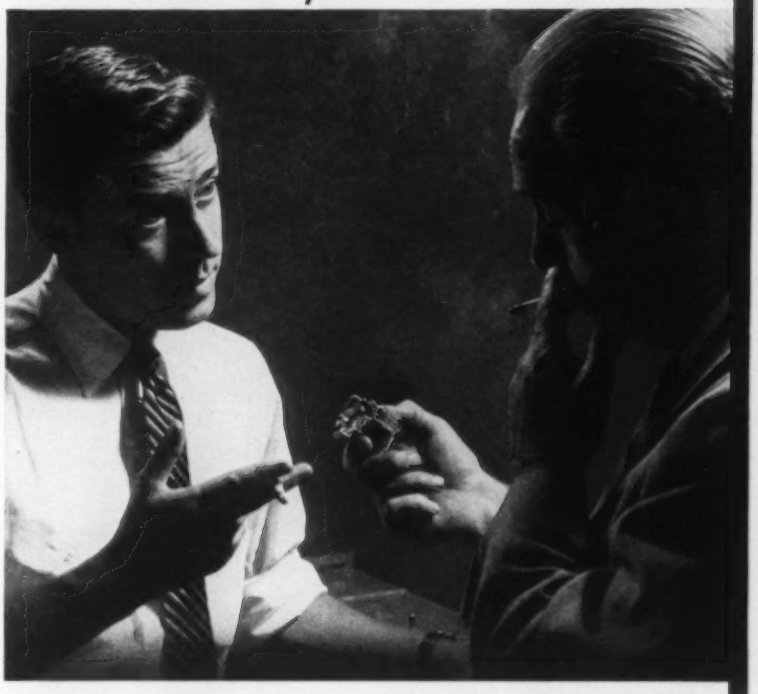
Machine Support

Item 424

Base is an air container of nylon-reinforced neoprene and cast aluminum, fitted with a pressure indicating gage. A unit is placed under each support point of a machine and connected to the factory air supply. The cushions of air isolate the machine from outside vibration and minimize those which may develop within the machine.

Pressure gage readings indicate

P&B PROGRESS / New! Ingenious Impulse Latching Relay



TWO COIL RELAY PERFORMANCE AT SINGLE COIL COST!

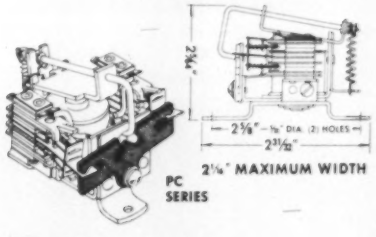
The PC employs a single coil and armature to activate an insulated rocker arm. Switching is positive, fast (30 milliseconds).

Low cost, dependability and versatility make it ideal for a wide range of uses in "off-on" applications.

The relay may be ordered open, as shown, or in a metal dust cover.

Write or wire today for complete information.

PC SERIES ENGINEERING DATA



Operate: 30 MS.
Terminals: Pierced Solder Lugs.
Coil: Two #20 AWG Wires.
Contacts: One #20 AWG Wire.
Enclosures: Dust Cover.

CONTACTS:
Arrangements: 4 Form C, max. (4PDT)
Material: ⅛" dia. Silver Cadmium oxide gold flashed.
Load: 10 amp. @ 115 V. AC resistive.
Pressure: 20 grms. min.

COIL:
Resistance: .016 to 34,500 max.
Power: DC, 9 watts; AC, 18.4 Volt Amps. } at nominal voltage.
Duty: Intermittant.
Insulation: Cellulose acetate wrap; varnish impregnated (open).

GENERAL:
Description: Single coil, impulse latching relay.
Insulating Material: Laminated Phenolic.
Insulation Resistance: 1500 megs min.
Breakdown Voltage: 500 V. RMS.
Ambient Temperature: —55°C. to +85°C.
Weight: 5 ozs. (open).
Pull-In: DC, 75%; AC, 78% } for nominal voltage.

MOUNTINGS:
Two ⅝₂" dia. holes on 2⅛" center.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

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AMF

Circle 691 on Page 163

MOLINE

HD68 drills bolt circles from 12" to 100" diameter. Each of the two spindles has capacity for 2½" drill in steel. Operating cycle is fully automatic.

HD13 straight line-type drilling machine with capacity for thirty ¾" drills in steel. Used for work on heavy castings, round and rectangular steel tubes, structural shapes, plates and grader blade drilling or countersinking.

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- Multi-Spindle Boring
- Single and Multi-Spindle Honing
- Straight Line Multi-Drilling
- Adjustable Spindle Drilling
- Vertical and Way-Type Fixed Center Drilling, Boring and Tapping
- Transfer-Type and Special Machines

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13CB hydraulic feed cylinder boring machine. V-8 engine blocks are rough and finish bored for wet-type cylinder sleeves. Units of this kind are applicable for transfer machines.

MR152 performs drilling, reaming, spot facing and chamfering operations on tractor rear axle housings. A companion machine, MR151, does tapping in addition to the foregoing operations. Work holding fixtures are mounted on power driven trunnion.

MOLINE TOOL CO. "Hole-Hog" MOLINE, ILLINOIS

MOLINE TOOL COMPANY
REPRESENTATIVES IN PRINCIPAL CITIES
100 20TH STREET • MOLINE, ILLINOIS

109

machine weight supported by each unit. A change in a gage reading indicates a change in machine alignment due to settling of the building or compaction of the ground under the machine. Bases are designed to support and indicate loads from 500 to 12,000 lb each with a 100 psi air supply. **Weber Instrument Co.**, 11301 Schaefer Rd., Detroit, Mich.

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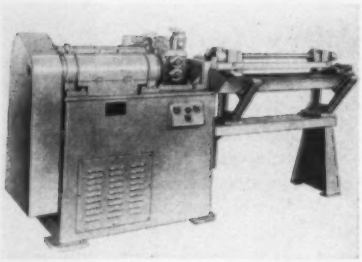

Wire Straightener/Cutter

Item 425

Machine cuts and straightens wire ranging in diameter from 1/16-inch to 5/16-inch. Model 2AV has a high speed straightening arbor with 5 elongated split dies mounted on ball bearings for minimum vibration. The automatic wire straightening and cutting machine has a variable speed unit which allows a choice of feed ranges from 50 to 200 fpm. The feed roll housing is totally enclosed. **Mettler Machine Tool Inc.**, Adeline & Blvd., New Haven, Conn.

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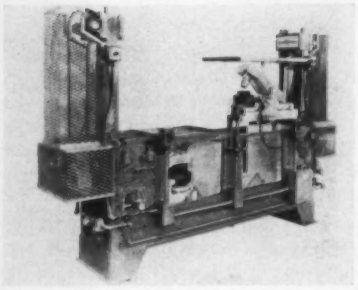

Air Leak Tester

Item 426

Unit shown is capable of making quantitative and visual leak tests on air spring assemblies. Accuracy of 90 per cent on leakage

rates as low as ¼ cc of free air per minute is possible. Quick-change fixtures, requiring no adjustment, allow changeover from front to rear, and left to right air springs. All moving parts are guarded, and a circulating pump and filter keep the water clear.

Another tester available checks front and rear leveling valves for leakage and opening and closing position, without resetting or adjustments. The valve to be tested fits snugly into a contoured receptacle to minimize air volume. High-pressure air mixed with inert gas is admitted into the valve. Leakage is detected and measured by a gas analyzer which attaches to an opening in the test receptacle. The vacuum pump of the analyzer washes a continuous flow of air through the receptacle across the part. A timer permits flow and leakage equilibrium to be reached before readings are taken. **Measurement Automation Div., Cargill Detroit Corp.**, Birmingham, Mich.

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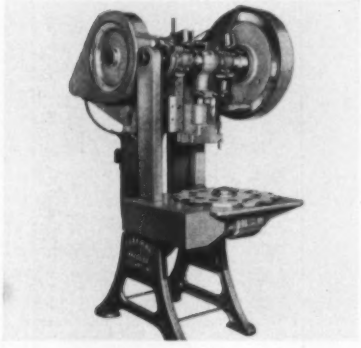

Dial Feed Press

Item 427

Unit features a chain drive for the indexing cam which allows more work area for the operator and permits the handling of larger work. The square design of the dial base provides an apron for the operator. It can be extended for the installation of hopper feeds. The indexing cam is driven by an automotive-type timing chain. The dial feed index rollers are sealed cam followers. Both the index plate and the work plate operate on ball thrust bearings. The shot pin is equipped with a tapered bushing to assure positive location at each index. The standard work plate

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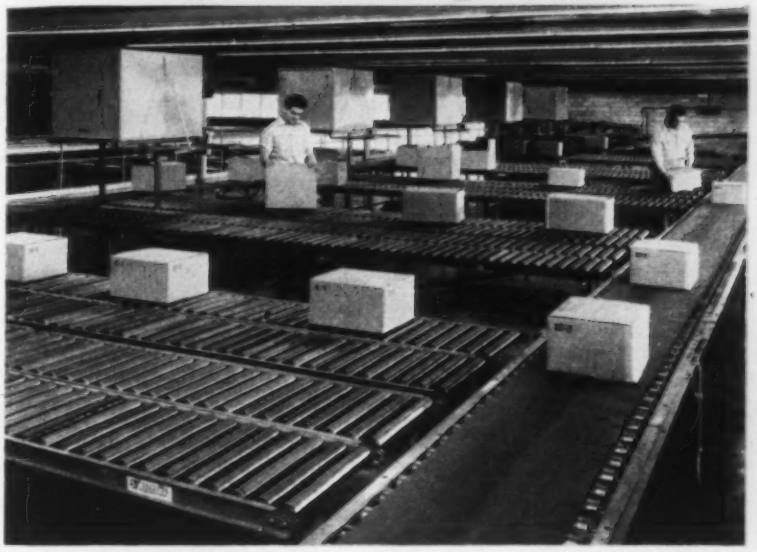
MATHEWS



A reversible General Purpose Belt Conveyer serving parallel roller conveyer storage lines.

THESE General Purpose Belt Conveyers are furnished in a wide range of belt widths and section lengths. They can be assembled easily, for all parts are standardized and furnished from stock. The conveyers have several features which make them especially practical for the average package handling problem. The drive unit may be located at the end, or at any convenient point beneath the conveyer. End roller assemblies, takeups, and three-pulley devices are all standardized and easily installed.

Floor and hanger supports have a wide range of adjustment, and are especially convenient in situations where conveyers must be arranged to meet production requirements.

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Circle 693 on Page 163

T-J spacemaker cylinder

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to give quality results

with Extras . . .
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RIVITORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHORS

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A. S. T. E. SHOW

Circle 694 on Page 163

moves clockwise, but can be furnished to operate in a counterclockwise direction. **Federal Press Co.**, Elkhart, Ind.

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Electronic Counter

Item 428

Designed for automatic counting operations, unit is suitable for high-speed bulk packaging operations, has counting capacity of one million discrete items. Device is also adaptable for use with box or bottle indexing devices. In this service, the unit automatically positions a new container underneath the batching device each time the previous filling operation has been completed by count. It is designed for change-over from one item to another without additional guides or other equipment. The machine can be constructed with two to ten orientation channels depending on the production requirements. Counting speeds up to 2 million pieces per hour can be attained with multichannel versions. **Delta Engineering Corp.**, 126 W. Emerson St., Melrose 76, Mass.

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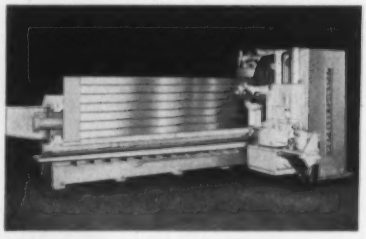

Sculpture Machine

Item 429

Tracer-controlled contour and profile milling is accomplished with

hydraulically driven sculpture machine. The unit has an infinitely variable spindle speed from 36 to 1900 rpm; a heavy main column with vertical and in-and-out feed movement, and a vertical slide designed to have rigidity for high metal removal capacity.

Unit can work a wide range of metals for large or small size jobs. Small size work can be tandem mounted and machined side by side. Machine tools are suitable for applications from rough cutting to finish machining. The sculpture unit is available in two sizes; 120-inch stroke, and 144-inch stroke. Both types have a cross travel of 24 inches. **Colonial-Romulus Div., Colonial Broach & Machine Co.,** Parkgrove Station, Detroit 5, Mich.

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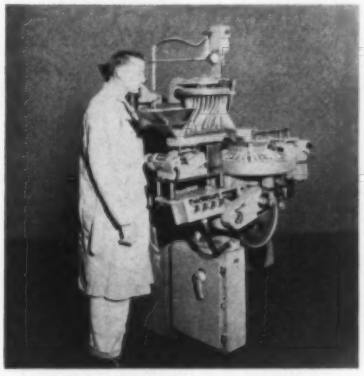

Coating Machine

Item 430

Unit applies dry coatings to capsule-shaped tablet cores at rates up to 925 tablets per minute. A slow-transfer feeder assembly is mounted on the coating machine. The cores are fed by a tablet duster into a metal hopper in the feeder. The cores fall through collector ring holes below the hopper and travel down V-grooves in a conical magazine feeder into slots in a core-positioning ring. The collector ring, magazine feeder, and core positioning ring rotate as a unit.

The magazine feeder is vibrated by an external vibrator assembly to assure positive feed of cores to the ring. Cores are picked up from the core positioning ring one at a time by vacuum pickup nozzles. The nozzles are attached to a special chain driven by the press die table. The cores are deposited by the noz-

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zles in dies which have been partially filled with a lower layer of dry granular coating material. The top layer of coating material is fed over the core in the die before the latter reaches the pressure rolls where the coating is compressed onto the core. Metering of the coating material layers assures accurate control of thickness. **Arthur Colton Co., Div., Snyder Tool & Engr. Co.**, 3400 E. Lafayette, Detroit 7, Mich.

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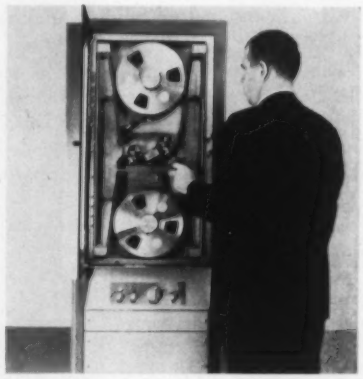
Digital Tape System

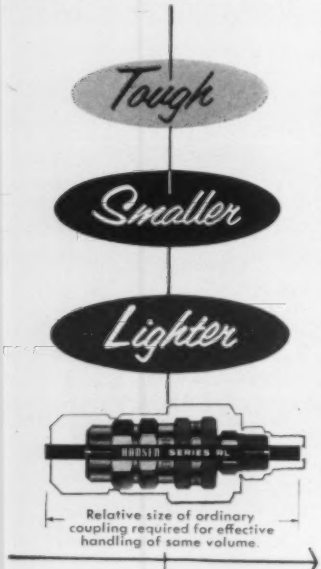
Item 431

Transfer rates as high as 90,000 characters per second is feature of digital computer input/output system. Unit consists of a tape handler, read/write heads, electronics, and magnetic tape. Tape handler operates at 150 in./sec and can record two six-bit characters side by side on 1-inch tape. It has repeatable start and stop time of less than 1.5 milliseconds.

The tape moves $\frac{1}{8}$ ±0.035-inch during the 1.5 millisecond start or stop interval. A special oxide binder on the tape reduces the amount of oxide that rubs off onto the magnetic heads, and increases the length of service that can be expected from the tape. **Ampex Corp.**, 934 Charter St., Redwood City, Calif.

Circle 431 on Page 163





EVERYTHING YOU WANT IN A QUICK-CONNECTIVE PNEUMATIC COUPLING

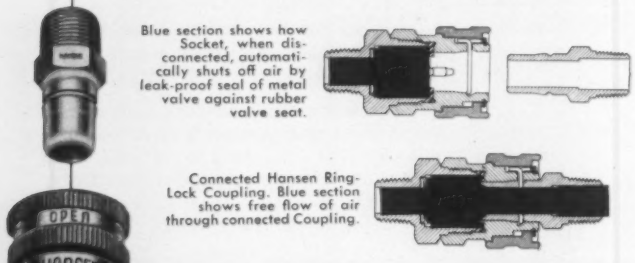
Hansen Series RL One-Way Shut-Off Couplings will handle any job in your shop using ¾" to ⅛" connections—from the air line to the air tool. All Hansen Series 2-RL Sockets and Plugs are interchangeable with each other. Likewise all Sockets and Plugs of the slightly larger, greater capacity Series 3-RL are similarly interchangeable with each other.

Consequently, by standardizing on either Hansen Series 2-RL or Series 3-RL Couplings, you eliminate any need for various size couplings in your hook-up—make it easy to keep stock of parts in balance—and hold inventories to a minimum.

Machined from solid steel bar stock, Plugs and Sockets are hardened and rust-proofed for long wear. Locking ring provides positive lock and assures tight fit. Equipped with automatic sleeve lock.

THE HANSEN SERIES RL

QUICK-CONNECTIVE RING-LOCK COUPLING


Blue section shows how Socket, when disconnected, automatically shuts off air by leak-proof seal of metal valve against rubber valve seat.
Connected Hansen Ring-Lock Coupling. Blue section shows free flow of air through connected Coupling.

WRITE FOR THE HANSEN CATALOG

Here's an always ready reference when you want information on couplings in a hurry. List complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for L.P. Gas, Steam, Oxygen, Acetylene, etc.

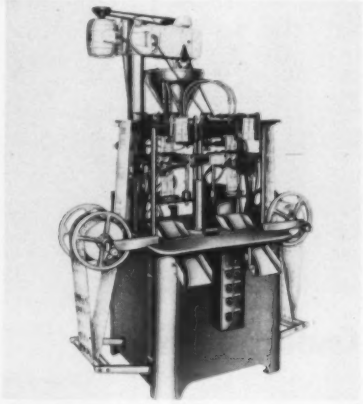
REPRESENTATIVES IN PRINCIPAL CITIES

SINCE 1915 — **QUICK-CONNECTIVE FLUID LINE COUPLINGS**

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

Circle 696 on Page 163



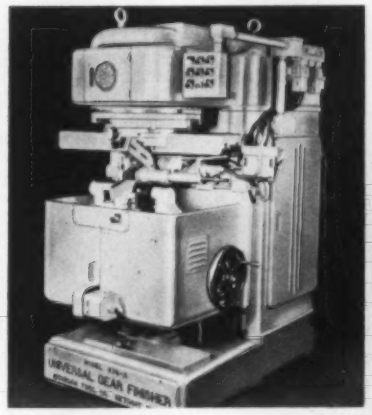
Liquid Packeter

Item 432

Device is designed to handle viscous, semiviscous, and free flowing liquids such as soaps, foods, and cosmetics. The machine measures the product and forms, fills, and heat-seals the packet in one continuous operation. Packets with notched or perforated dispensing spouts can be produced. Packets are formed from individual rolls of heat-sealing materials. A momentary vacuum action of the feed pump allows sharp product cutoff and eliminates faulty packets. An electric eye registration on both sides of the packet assures centered trade marks and labels. The unit fills and forms up to 8 packets per cycle at 25 to 50 cpm. **Brown**

Filling Machine Co. Inc., Fitchburg, Mass.

Circle 432 on Page 163



Gear Loader

Item 433

Designed for a line of universal rotary gear finishing machines, attachment features speed, positive positioning, and automatic ejection. Device can be equipped with gaging gears at the entry end of the feed chute to prevent oversize parts from entering the loading slide.

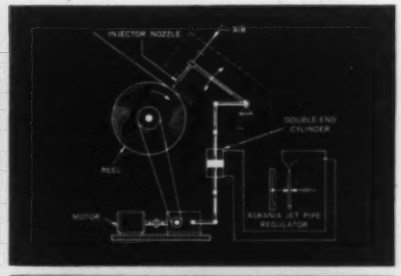
In operation, gears roll down a gravity chute. A pneumatic cylinder-operated plunger then places a part into the loading shuttle, which is also pneumatically operated. The shuttle carries the gear to the shaving position where the gear is picked up by air-operated centers or plug-type locators. The gear is then in mesh with the finishing cutter. A sensing device prevents the centers from entering the part if the part is not meshing properly with the cutter. If this happens, the shuttle will return and repeat the loading operation until proper meshing takes place. After finishing, the centers withdraw and the shuttle returns the gear to its *out* position. A plunger, operated by a limit switch-controlled pneumatic cylinder, simultaneously moves the gear from the shuttle into the ejection chute and places the next gear into the shuttle. An optional accessory is a preset counter which indicates by a signal light when the shaving cutter should be checked for need of sharpening. **Michigan Tool Co.**, 7171 E. McNichols Rd., Detroit 12, Mich.

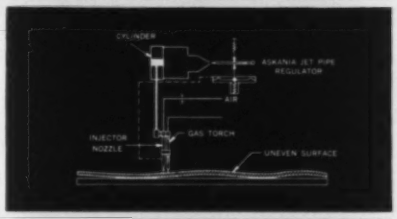
Circle 433 on Page 163

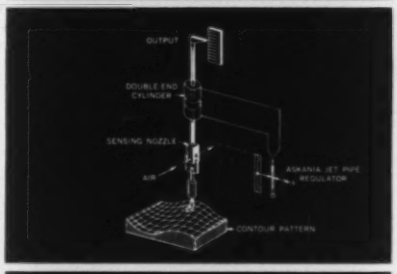
Circle 697 on Page 163→

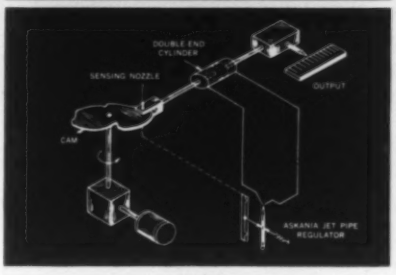
Powerful, accurate position control from

a breath of air!









Askania Jet Pipe Principle makes possible non-contact, high-output position servos

A breath of air that will just barely hold a feather aloft is all it takes for accurate sensing of a surface position in a system that incorporates the Askania Jet Pipe relay. High-level output from extremely low pressure signals is a built-in feature of Askania hydraulic controls.

The four examples shown here are only hints of what you can do with this proved hydraulic amplifier. As a cam follower that responds rapidly without making contact with the cam; as a three-dimensional cam follower; as a guide for a cutting torch with warped or irregular material; as a servo based on continuous diameter measurement – wherever you can use non-contact position or proximity measurement – you can do it easier and better with Askania controls.

Power output is almost unlimited. Speed of response is unusually fast. Mail the coupon below for all the facts about this unique and useful system.

ASKANIA

GENERAL PRECISION EQUIPMENT CORPORATION GPE

STRAIGHT-LINE AUTOMATIC CONTROLS FOR INDUSTRY

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SYSTEMS ENGINEERING

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VALVE ACTUATORS AND CYLINDERS

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HYDRAULIC POWER AND PRECISION FOR AUTOMATIC CONTROL

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244 E. Ontario Street, Chicago 11, Illinois
Please send me details about Askania Air-Hydraulic non-contact position servo systems.

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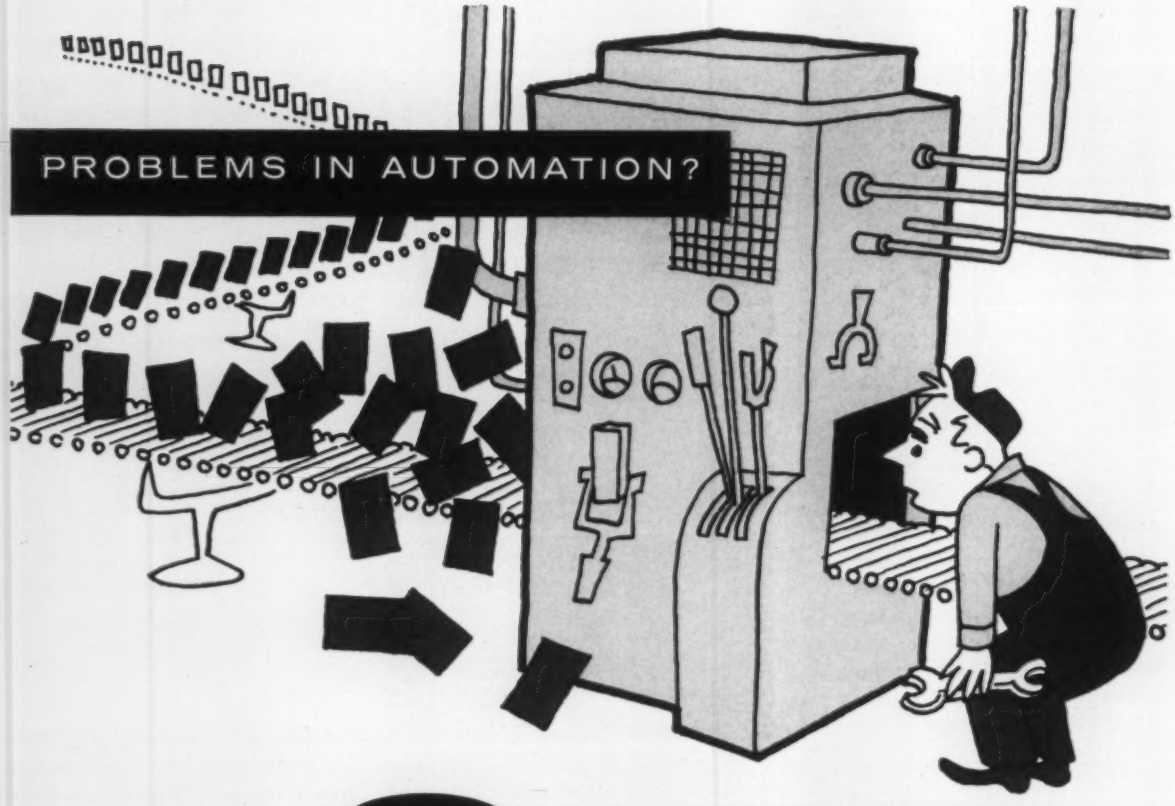

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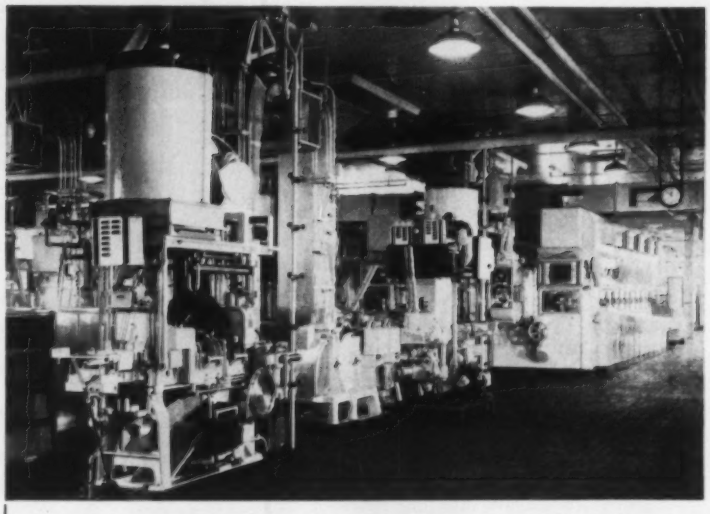
To produce the intricate, precision equipment for its own highly automated manufacturing lines, Canco maintains four large machine shops. Each shop is staffed with experienced engineers, designers and machinists capable of designing and making any type of high-speed, automatic machinery, as well as dies, fixtures, tools and individual parts.

These facilities are available to you for contract and sub-contract work. For further information, write to the shop nearest you.



Canco machine shops are located at:

GENEVA, N. Y., North Genesee St. and Lehigh Valley RR • Geneva 8111
NEWARK 12, N. J., 320 Elizabeth Avenue • Bigelow 8-1100
CINCINNATI 23, OHIO, Spring Grove Ave. and Fergus St. • Kirby 1-2381
SAN FRANCISCO 10, CAL., 499 Alabama Street • Market 1-5480

CANCO **American Can Company**

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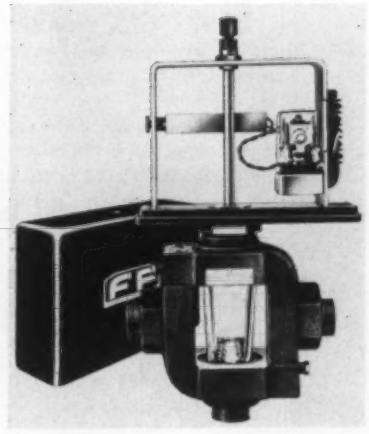
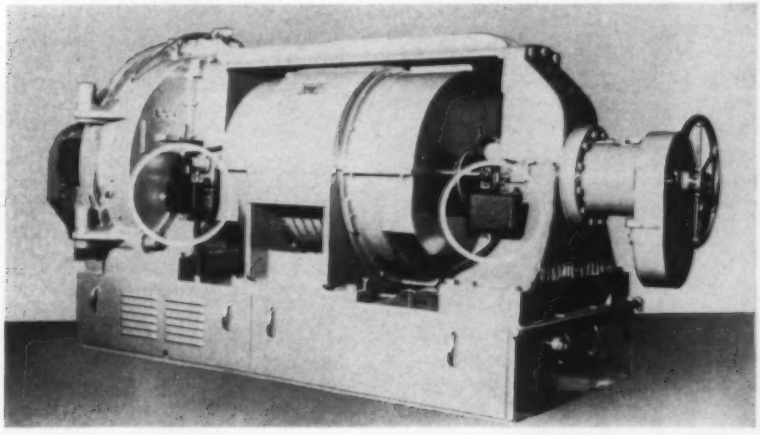
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 163.





Vibration-Proof Flow Alarm

UNIT designated the Ratolarm is designed for use with a flow meter which can position a control rod. The alarm contains a dry reed switch assembly which is actuated by a magnet on the control rod and gives an electrical signal for high or low limits. The switch can be positioned in the mounting frame either above or below the magnet on the control rod. The dry reed switch is located on the frame at a previously determined point, corresponding to a value of the variable at which the electrical signal is desired. If the switch is placed above the magnet, it will set off the alarm when increasing flow causes the magnet to rise to a predetermined position. If placed below the magnet, it sets off the alarm when the flow falls below the desired rate or fails entirely. Multiple switch assemblies can be incorporated for special applications.

The magnetic dry reed switch is composed of two reeds of permeable, soft, iron-nickel alloy hermetically sealed in a glass enclosure. The switch proper is enclosed in a nonmagnetic housing and protected from shock damage by a cylindrical rubber grommet at each end. The switch housing cover is designed to allow limited movement horizontally to facilitate installation. Leads extend through an opening in the switch enclosure to plug into the relay base. A bias magnet is assembled inside the switch housing to provide the equivalent of a spring-loading feature. This bias magnet is used to hold the switch contacts in either an open or closed position until the float extension magnet actuates the switch.

One of the frequent applications as a flow alarm is in water or oil cooling lines for large machines. As shown in the picture, alarm is used with a refiner built by **Sprout, Waldron & Co. Inc.** The high speed bearings of the unit which is used in refining wood pulp for paper and board manufacture, are protected by interlocking the motor starter with two alarms. The operator cannot start the refiner unless the lubricating oil is flowing to the bearings. If the oil flow stops, the alarms automatically shut down the refiner before the bearings overheat and become permanently damaged. **Fischer & Porter Co.**, 553 Jacksonville Rd., Hatboro, Pa.

Circle 434 on Page 163

Digital Voltmeter

Item 435

Device is applicable in telemetering and test system calibration; computer input, output, and ref-

erence supply measurements, production testing of electronic instruments; and chemical and other industrial process control. Model 401 consists of a chopper stabilized reference supply and potentiometer, a difference amplifier, a chopper which drives the difference amplifier, and a stepping switch network.

In operation, the difference between the feedback voltage and the input voltage is sampled by the chopper and applied to the difference amplifier. Any voltage difference between the two is amplified by the difference amplifier and applied to the stepping switches, which in turn adjust the tap on the reference supply potentiometer until the feedback voltage equals the input voltage. When both voltages reach equilibrium, parallel contacts on the stepping switches light the appropriate readout indication. The reference supply uses a chopper-stabilized circuit to continuously compare the reference voltage against an internal standard cell, providing an extremely stable and accurate reference voltage.

Voltmeter displays four digits in ranges from 0.0001 to 999.9 volts plus an automatic polarity indication and automatic decimal placement, has accuracy to 0.01 per cent or 1 digit, and has an average balance time of one second. Power required is 155v, 60 cycle, single phase, approximately 85 va. **Kin Tel, Div. Cohu Electronics Inc.**, 5725 Kearny Villa Rd., San Diego 11, Calif.

Circle 435 on Page 163

Magnetic Clutch

Item 436

Designed for use on ball mills, rod mills, compeb mills, kilns, and similar heavy duty applications, electromagnetic disc clutch has a maximum torque of 120,000 ft lb, and 4,878 sq in. of lining area. Drive and driven hubs are detachable, allowing the entire clutch operating mechanism to be removed without disturbing the shafts. The drive end of the unit carries the friction elements. To adjust the clutch for wear, a lock pin is depressed and the armature is rotated to the next notch. The clutch can be operated from a master control panel or other remote location and operates from dc supply. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

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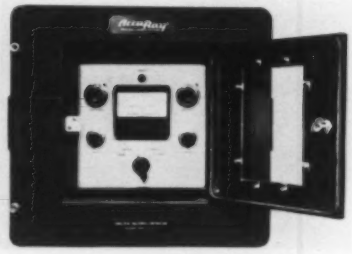

Density Measurement

Item 437

Gamma ray system is capable of measuring and controlling fluid density, specific gravity, percent solids, or related quantity. It is applicable to liquids, slurries, and flaked, granulated, powdered, or other finely divided solids. The flowing material has no physical contact with the system; measurements are also independent of flow rate and pressure.

Density measurement system can be furnished with sensitivities to the order of 0.0001 specific gravity. Built-in standardizing circuits maintain accuracy and calibration, and any component except radiation source or detector can be replaced without affecting calibration. The measuring head of the system is constructed of heavy corrosion resistant castings welded on a section of pipe. The unit is designed to withstand shock and vibration under adverse industrial conditions. The power-supply-amplifier unit, which can be located hundreds of feet from the measuring head, is in a panel-mounted enclosure with a locking control-access door. An automatic built-in compensation for changes in density of measured material due to changes in its temperature is also available. **Industrial Nucleonics Corp.**, 1205 Chesapeake Ave., Columbus 12, Ohio.

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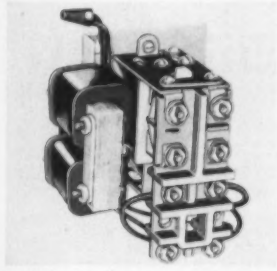

Liquid Level Control

Item 438

Available in two and three-pole designs, control unit is unaffected by acids or caustics. It is suitable for solutions such as water, sewage, and all types of acids or alkalies. The moving parts are located behind a protective panel, none are in the liquid. Unit is unaffected by pressure or temperature, operates on ac, 2 w, open circuit, and less than 5 w, closed circuit. **Charles F. Warrick Co.**, Dept. 13, 1964 W. Eleven Mile Rd., Berkley, Mich.

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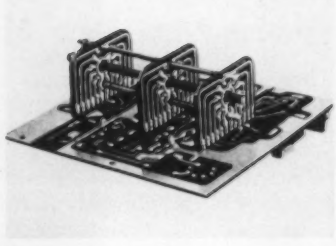

Printed Circuit Switch

Item 439

Adaptable to computers, test instruments, and any other electronic circuits requiring multiple switching, printed circuit rotary switch is designed for plug-in installation. Device includes a standard rotor and XXXP phenolic wafers. Manual wiring and soldering to each individual contact terminal are eliminated, but the contacts are the same as those on conventional switches. Plugging in the switch, and dip soldering the printed circuit board is all that is required for installation. Switch is available in 8 or 12 position types, in single or ganged assemblies to meet specific

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SPECIAL PURPOSE

Electrical Controls

Insure: Higher Efficiency
Freedom from Trouble
Lower Cost

PANELS

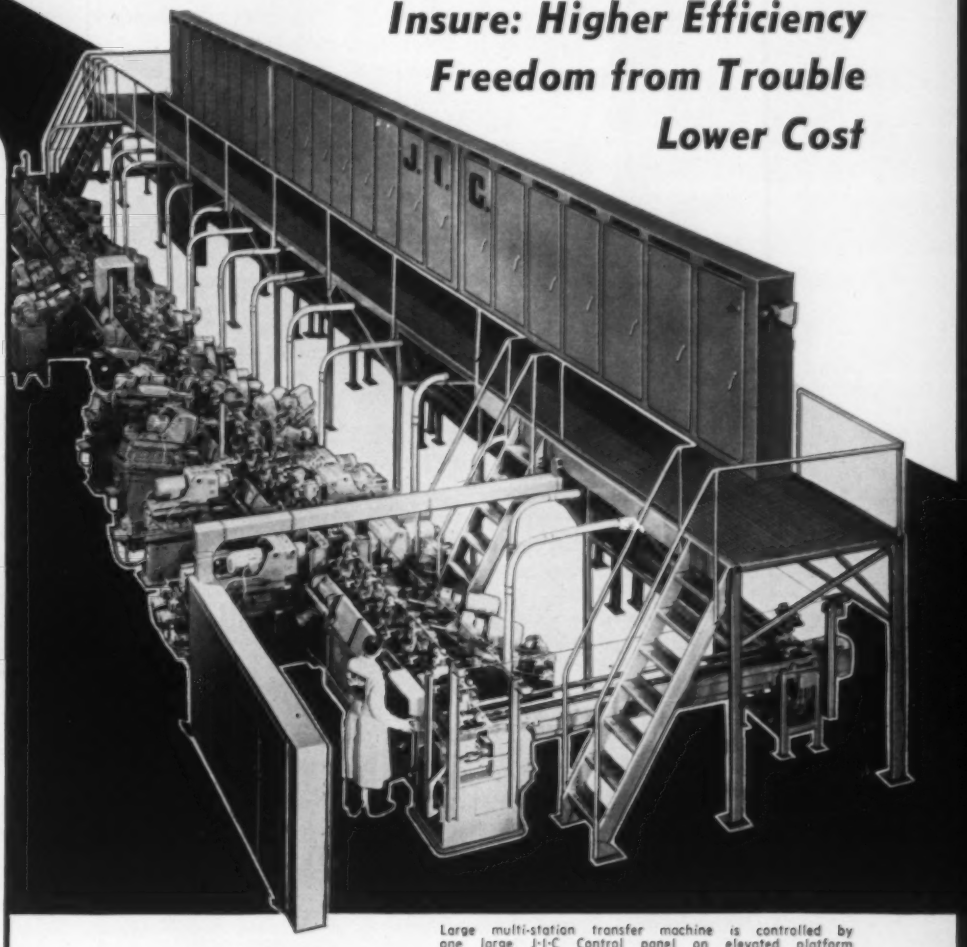
Designed in a wide variety of sizes for unlimited control of countless operations.

CONSOLES

Push buttons are grouped in relative locations to avoid confusion. Visual signals tell operator of trouble at any station.

STATIC CONTROL

J.I.C. Electric Company again is first in designing and building one of the newest and most advanced control systems using Static Control.



Large multi-station transfer machine is controlled by one large J-I-C Control panel on elevated platform

Unitized Structure Saves Space—Improves Economy

J.I.C. Control panels are specially designed and built by a staff of engineers and craftsmen of long experience and outstanding ability. Standardization of components has proven the key to longer service, lower first cost, higher efficiency and improved operation. Work simplification is a first consideration in every J.I.C. design.

J.I.C. ENGINEERS ARE SPECIALISTS IN DESIGNING AND BUILDING ELECTRICAL CONTROL PANELS

Our panel men and engineers specialize in designing and building all types of Electrical Control Systems. They will lay out a system to your standards.

A QUOTATION FROM J.I.C. TODAY CAN SAVE YOU TIME AND MONEY

Circle 699 on Page 163

J·I·C **ELECTRIC COMPANY**

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Please send the Bulletins checked below:

- ☐ Load Switch Bulletin
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requirements. **Knight Electronics Corp.**, 210 S. Desplaines St., Chicago 6, Ill.

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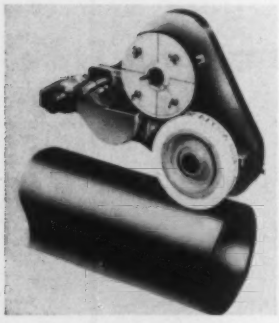

Offset Printer

Item 440

Unit provides continuous, lineal printing on steel, aluminum, or plastic pipe, bars, or tubing. Printer is mounted directly over a moving production line, can print on an unlimited range of product sizes from ½-inch OD and up. Model 248 can print data such as trademarks, coil numbers, sizes, dates, gages, and weight per foot. A rubber printing roll conforms to the radius of the material being marked and prints continuously at speeds as high as 1,000 fpm. **Jas. H. Matthews & Co.**, 3945 Forbes St., Pittsburgh 13, Pa.

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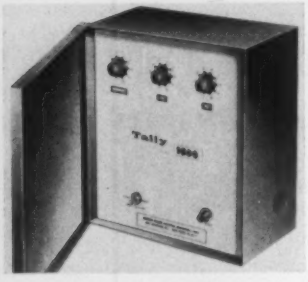

Predetermined Counter

Item 441

Applicable on operations such as packaging, batching, cutting of specific lengths, and controlling of sequential operations, predetermined counter can be actuated by a photoelectric control, limit switch, or any single-pole switching device. Unit has counts from 1 to 1,000 at a rate up to 450 per minute. After each completed count, instrument automatically recycles to zero position. A command switch permits the operator to stop the counter from automatically recycling. Counter is rated 115 or 230v, 60 cycle ac, 25 w, single pole, double throw, 10 amp noninductive load. Actuator contact time is 50 milliseconds minimum. **Hobson Miller Machinery Corp.**, 280 Lafayette St., New York 12, N. Y.

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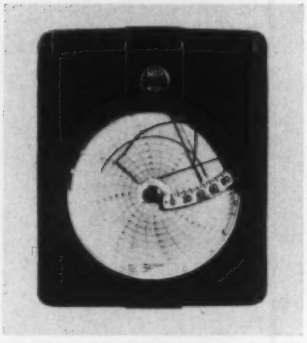

Program Controller

Item 442

Applicable in industrial processes such as programming the operation of batch cooking processes, or controlled drying, instrument receives, records, and programs variables within a single recorder case. Predetermined program is cut into a six-inch diameter cam. The cam positions a pneumatic transmitter to establish a set point signal for system's control relay. The controller also drives a recording pen to record cam program on same chart with actual value of controlled variable.

Two manual adjustments are provided; any portion of the program can be omitted or repeated with time-set knob, or the set point can be offset up to ±5 per cent with a micrometer type adjustment. A screwdriver adjustment on calibrated timing discs precisely times the operation of snap-action switches. During any given cycle, external functions can be automatically performed many times; or by the use of a stepping switch, several functions can be performed in sequence. Power supply required is 115v, 25, 50, or 60 cycles; switches are single-pole, double-throw 115v, 3 amps; cam speed is 1, 4, 6, 8, 12, or 24 hours per revolution. **Bailey Meter Co.**, 1050 Ivanhoe Rd., Cleveland 10, Ohio.

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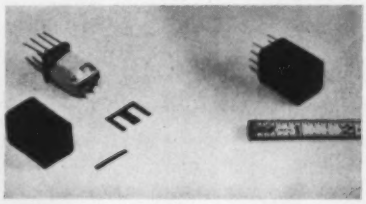

Miniaturized Transformer

Item 443

Designed for mounting on printed wiring boards, miniaturized transformer can handle a wide range of audio and carrier frequencies. Core structures of the unit are nickel-iron laminations for audio frequency units, and ferrite for the carrier frequency ranges. Windings are of polyurethane-insulated copper wire, separated by Mylar. After assembly the units are filled with an epoxy casting resin for good performance under extreme humidity and temperature conditions. Unit is available in cases measuring 1-1/16 by 3/4 by 3/4 inch or 1-1/8 by 1-1/16 by 15/16. **Telecommuication Div., Stromberg-Carlson Co., Div. General Dynamics Corp.**, Rochester 3, N. Y.

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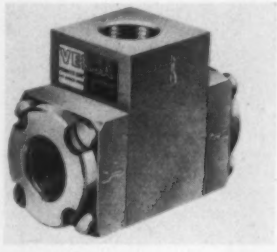


Shuttle Valve

Item 444

Unit is designed for the charging and discharging of pressure cylinders through the actuation of any one of two or more three-way valves located at remote control stations. Design prevents the air from the valve that is being actuated from being vented to the atmosphere through the exhaust ports of the nonactuated valves. Unit features an antiextrusion arrangement of all the O-ring seals to provide airtight-

Avoid costly down-time caused by electrical control failure....

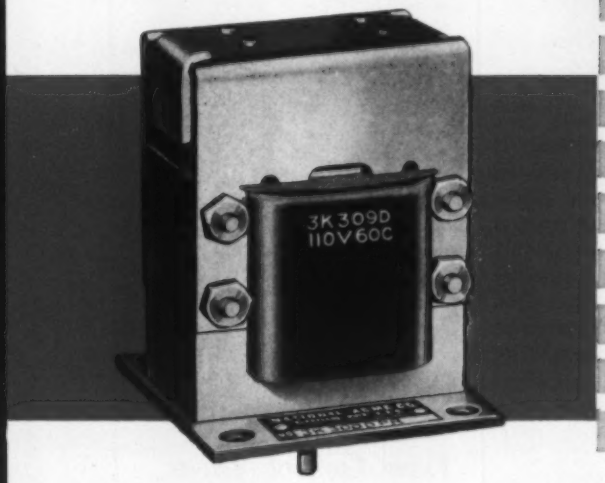
Nothing is more frustrating to the production man than downtime caused by the failure of a minor component. An $85,000 machine tool down because of a failure of a limit switch can be as expensive as if it were caused by a main bearing burnout. National Acme's electrical controls are designed by machine tool designers and built as machine tools are built. That means extra ruggedness, extra dependability but it does not mean extra cost.

GOLD-N-RING CONTROL SWITCHES

Oil-tight, water-tight, dust-tight. Built with heavy duty silver alloy contact points, over-size terminal screws, superior dielectric materials. For full information ask for a free copy of Bulletin ECS-56.

LIMIT SWITCHES

A full line of heavy duty Limit Switches designed originally for machine tool installation but now used wherever extra dependability, extra ruggedness and long life are required. For full information ask for a free copy of our Bulletin EM-51.



NAMCO SOLENOIDS

A full line of standard and custom made Solenoids for AC or DC use. Push or pull types with capacities up to 25 lbs. Bulletin EM-52A provides information on the application, design and installation of Solenoids. Write for your free copy today.

Electrical Manufacturing Division

National Acme

THE NATIONAL ACME COMPANY • 196 E. 131st St. • Cleveland 8, Ohio.

Circle 700 on Page 163

ness after more than three million cycles of operation. The arrangement also eliminates the possibility of cutting the seal rings in the normal operating pressure range. Valve is available in 1/8, 1/4, 3/8, and 1/2-inch sizes, for pneumatic or hydraulic control. **Versa Products Co. Inc.**, 249 Scholes St., Brooklyn 6, N. Y.

Circle 444 on Page 163

Thermocouple Cable

Item 445

Thermocouple extension wire is available in multipair cables with over-all polyvinyl plastic sheath. Cable is recommended when four or more pairs of wires are needed, and permits the use of smaller conduits than needed for the same number of individual pairs. The smooth surface eliminates the necessity of coating to facilitate conduit pulling. Cable is rated at 221 F, and has sufficient rigidity and resistance to atmosphere and moisture that it can be hung without conduit, installed in open trough, or used for direct burial. **Claud S. Gordon Co.**, 3000 S. Wallace St., Chicago 16, Ill.

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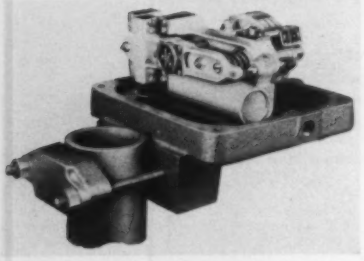
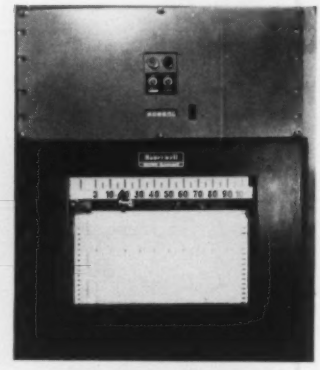


Process Transmitters

Item 446

Instruments use a gas filled thermal system for temperature measurement, and a bellows element for pressure. Temperature and pressure transmitters are designed so subassemblies can be removed without disturbing balanced beam assembly. Thermal system and pressure element can also be removed for change of range span. A derivative unit which compensates for lags in the thermal system can be added on the underside of the baseplate, and requires no tubing or fittings. Provision is made for an integral receiver gage to be mounted directly on the baseplate without external connections. The transmitter can be mounted in any position without positional error. **Mason-Neilan, Div., Worthington Corp.**, Nahatan Street, Norwood, Mass.

Circle 446 on Page 163



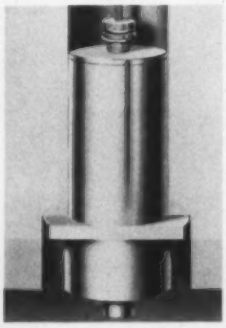
Continuous Integrator

Item 447

Unit is capable of totalizing, over a period of time, rapidly changing process variables which are convertible into an electrical signal. It is suitable in chemical and refining operations to measure total power consumed in the electrodeposition of metals and for chromatography in measuring the relative quantity of component parts in gas mixtures.

The records of variables such as temperature, flow, pressure, kilowatts and Btu's can be integrated on any strip or circular chart recorder whose transmitting slidewire has a linear output and a resistance between 20 and 250 ohms. Instrument reads out the integration on a six-digit counter and on the chart record by means of a dual pipping pen. Full scale count rate is continuously adjustable up to a maximum of 500 per minute when a pipping pen is used or 1,000 per minute otherwise. Accuracy of the unit is rated at ± 0.5 per cent. **Brown Instruments Div., Minneapolis-Honeywell Regulator Co.**, Wayne & Windrim Avenues, Philadelphia 44, Pa.

Circle 447 on Page 163

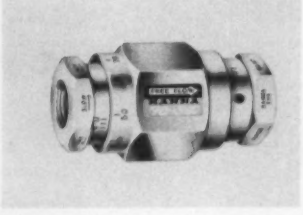


Magnetic Scrap Control

Item 448

Developed for stamping and shearing operations, magnetic device is mounted in a die and controls ferrous metal scrap in the die. The press closes and the die shears the part. The part falls from the die as the press opens. The magnet holds the scrap out of the way and, at the proper instant a kick-off knocks the scrap away from the die into a receiving tray. The material is then moved into position for the next operation. Four models are available, ranging in ratings from 27 average foot pounds pull off to 250 average foot pounds pull off. **Machine Tool Electric Corp.**, 706 Sheridan St., Lansing, Mich.

Circle 448 on Page 163



Flow Control Valve

Item 449

Applicable in controlling the piston speeds of hydraulic cylinders and for controlling the speeds of other hydraulically operated devices, valve is rated for 1000 psi hydraulic operation. When used with cylinders, the instroke and outstroke speeds are regulated separately by means of a free flow

Circle 702 on Page 163→

EATON

DYNAMATIC®

SINGLE PACKAGE

FRACTIONAL HP AJUSTO-SPEDE® DRIVES

Provide Stepless Adjustable Speed from an AC Power Source

STANDARD

WITH FRICTION BRAKE

WITH SPEED REDUCER

Sizes and Types for Hundreds of Industrial Applications

Dynamatic Ajusto-Spede® Drives, part of a family of diversified eddy-current equipment, provide an economical solution to many adjustable speed drive problems.

The Fractional Horsepower Ajusto-Spede, a single package design, combines an AC constant speed induction motor, eddy-current coupling, and electronic control. Standard modifications provide for the addition of electrically operated fail safe friction brakes, or speed reducers with numerous gear reduction ratios.

Fractional Horsepower Ajusto-Spede Drive power is taken directly from 115/220 volt, single phase or 220/440 volt, 3 phase lines. Sizes are ¼, ⅓, ½ and ¾ horsepower at 1600 RPM; ½, ¾ and 1 horsepower at 3200 RPM.

Friction brakes for quick stopping or fast cycling operation are furnished in two capacities—1½ and 3 pounds feet of torque.

Gear reductions with 10 ratios between 5-to-1 and 100-to-1 are supplied with 1600 RPM and 3200 RPM Ajusto-Spedes.

Ajusto-Spede® Advantages

- ★ **Constant torque speed range: 25 to 1 with either 1600 RPM or 3200 RPM Ajusto-Spedes.**
- ★ **Control accuracy: 2 per cent of top speed at any point within the speed range.**
- ★ **Minimum wiring to power line.**
- ★ **Remote "one knob" control operation up to 100 feet.**
- ★ **Rugged plug-in type integral one-tube electronic control.**
- ★ **Permanently sealed grease-packed bearings.**

For more detailed information, write for your free copy of the Dynamatic Fractional Horsepower Ajusto-Spede Bulletin, FAS-6.

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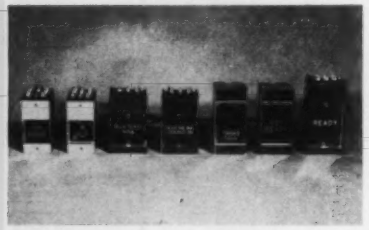
DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 701 on Page 163

through the valve in one direction and a controlled flow through the valve in the opposite direction. The flow can be controlled from zero to full capacity with only one revolution of the calibrated adjustment sleeve. When the desired flow rate has been established, the sleeve is locked in position by a set screw and locking collar. **Hanna Engineering Works**, 1765 Elston Ave., Chicago 22, Ill.

Circle 449 on Page 163



Readouts

Item 450

Devices convert electrical signals directly into readable characters. Digital and message readouts are available for process control, condition indicators, digital computers, and display of any numerical quantity. The digital readouts present lighted digits zero through nine and decimal point, or other information such as polarity signs or special symbols. The design allows side by side mounting of the units for in-line presentation of information. Message readouts will display, separately in one panel area, up to three different, color-coded, printed messages. Units are designed for operation on 6, 14, or 28v. **Milman Engineering Co.**, 1831 Pontius Ave., Los Angeles 25, Calif.

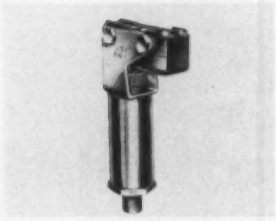
Circle 450 on Page 163

Pressure Control

Item 451

Suitable for applications where space and weight are limited, Model J51 is available in four models with adjustable ranges of 50, 75, and 250 psi between zero and 350 psi limits. On-off differentials between the limits of 5 and 10 psi can be obtained, depending on the model.

Pressure settings are uncalibrated,



and are made by a knurled adjustment wheel located inside the switch bracket between the bellows and the switch. Unit is available in any one of three standard switch types—normally open, normally closed, or double-throw with no neutral position. Switch is rated up to 15 amps at 115 or 230v ac. **United Electric Controls Co.**, 79 School St., Watertown, Mass.

Circle 451 on Page 163

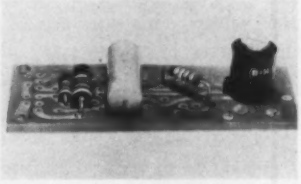
Speed Changer Belting

Item 452

Belt material is adaptable for use on variable speed drives such as found in bakeries, dairies, printing, bottling, machine tool, and metal working industries. Belts reduce vibration, can be adjusted to any required length, and installed without dismantling machinery. Each belt

is composed of a series of links secured by fasteners. Constructed of oil and heat-resistant neoprene, it is available in a wide range of sizes. **Manheim Mfg. & Belting Co.**, Manheim, Pa.

Circle 452 on Page 163

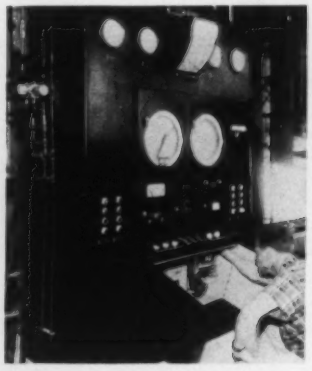


Miniature Potentiometer

Item 453

Model DM mounts directly to chassis or printed circuit either manually, or by machine. Wire wound unit is $\frac{1}{2}$-inch in diameter, 0.1 ounce in weight. It is available in 0.6w, from 10 to 50,000 ohms, with a resolution of 0.2 per cent. Potentiometer is shock tested to 40g, 3 planes, has no electrical noise under 25g, 3 planes. Features include 320 degree rotation, temperature range -55 C to $+150$ C, and retention of setting during vibration and shock. An O-ring seal protects against moisture, dust, and salt. **B-H Electronics**, P. O. Box 25124, Los Angeles 25, Calif.

Circle 453 on Page 163



Combustion Control

Item 454

Device is designed to provide automatic operation of single-burner gas, or oil-fired boilers. Package includes a control panel, completely piped and wired combustion control equipment, flame failure equipment, safety shutoff valves, and complete start up and shutdown programming. Unit is designed so that the operator need only connect fuel lines, steam lines, and the power supply.

Safety interlocks in the control system include low water cutout, low gas pressure, low oil temperature, low oil pressure, low atomizing steam pressure, and provision to fail safe on loss of electrical power. Both fuel and air are metered at the ratio controllers. The metering of fuel is accomplished not by static pressure measurement, but by velocity head measurement across an orifice, burner, or other restriction. Air flow measurement is provided by velocity head measurement with a pitot tube, frictional resistance across a section of the boiler, or velocity-friction head measurement across

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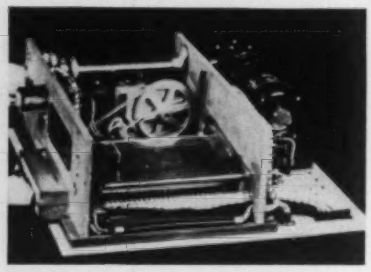
DIVISION OF **Crown Zellerbach Corporation**

the burner. Field of application of the control is from 6000 lb per hr packaged steam generators to 100,000 lb per hr boilers. **Hays Corp.**, Michigan City, Ind.

Circle 454 on Page 163



Punched Card Reader

Item 455

Device is designed for use with industrial processing and control systems. Reader accepts a standard punched card having as many as 80 vertical columns with 12 punching positions in each column. As a punched card is put into the reading slot, rollers automatically place it is reading position. A signal light indicates the unit is sensing the card, and a switch automatically activates associated control equipment. When the card is no longer needed, it is automatically removed. Cards inserted upside down are ejected. Unit operates on 110v, 60 cycles, is available with four bottom plate configurations and a top plate with up to 960 electrically insulated connecting points. **Electronics Div., Peerless Electric Co.**, Warren, Ohio

Circle 455 on Page 163

Preset Counter

Item 456

A panel switching arrangement permits use of this instrument as either a totalizing counter at rates up to 5000 counts per second, or as a preset counter adjustable from 1 to 9,999 counts at rates up to 1,000 counts per second. A rear panel test switch connects the power line frequency to the counter in test position and permits use of the instrument as a preset time interval generator adjustable in 1/60 second increments for accurate cycle timing of welders, processes, and other timed operations. An optional batch counter also totalizes batches at rates up to 600 per minute. Model 4150 is rated 105-130v ac, 50-60 cps, 80w. **I-L-S Instrument Corp.**, 4526 W. 160th St., Cleveland 11, Ohio.

Circle 456 on Page 163

Pilot Valve

Item 457

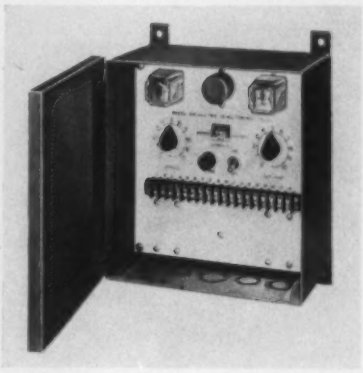
Line of solenoid air valves may be used for primary applications and to control the operation of company's pilot-operated master valve series. Each valve in the series has been pre-tested for performance at better than 600 cpm. Solenoid has a shock-resistant mounting in the valve cover, is inoperative when the cover is off. There is no metal-to-metal contact with stationary parts, any excess energy on closing impact of the plunger is effectively absorbed. Two accessory manual attachments, a ball type and a screwdriver type, are available. Current requirements are 0.8 amp in-rush and 0.125 amp holding at 115v, 60 cycles. Working pressure is 150 psi. **Mechanical Air Controls**, 10030 Capital, Oak Park, Detroit 37, Mich.

Circle 457 on Page 163

Control Relay

Item 458

Designed for use with company's weighing cell, the Model 219 relay is suitable for checkweighing and rejecting under and overweight packages; sorting into weight groups; and accurate process control of



preset weight limits. Control of the two-level control relay is automatic. The use of transistors and magnetic amplifiers provides high speed and reliability. Unit is rated 25w, 115v, 60 cycle ac. Contacts carry 2 amps noninductive load. Relay has a set point control for adjusting the center of the acceptance range and a spread control for adjusting the width of the acceptance range. Response time is less than 1/10 second. **Avion Div., ACF Industries Inc.**, 11 Park Place, Paramus, N. J.

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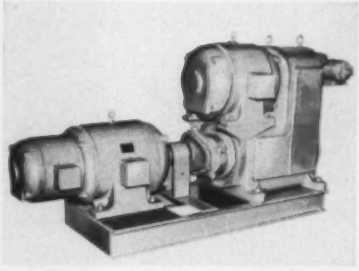

Variable Frequency Supply

Item 459

System supplies variable frequency current to control the speed of slave motors. It is applicable in synchronizing interrelated equipment, splitting the drive load on conveyors, and converting machine tools from constant to variable speed. All sizes of ac motors are controlled in unison and in proportion from the single source. A 500 per cent frequency range allows a 5 to 1 speed variation. Unit consists of an Electra Frequency Changer driven by a mechanical variable speed drive. It is available for manual, remote, or automatic control. **Electra Motors Inc.**, 1110 Lemon St., Anaheim, Calif.

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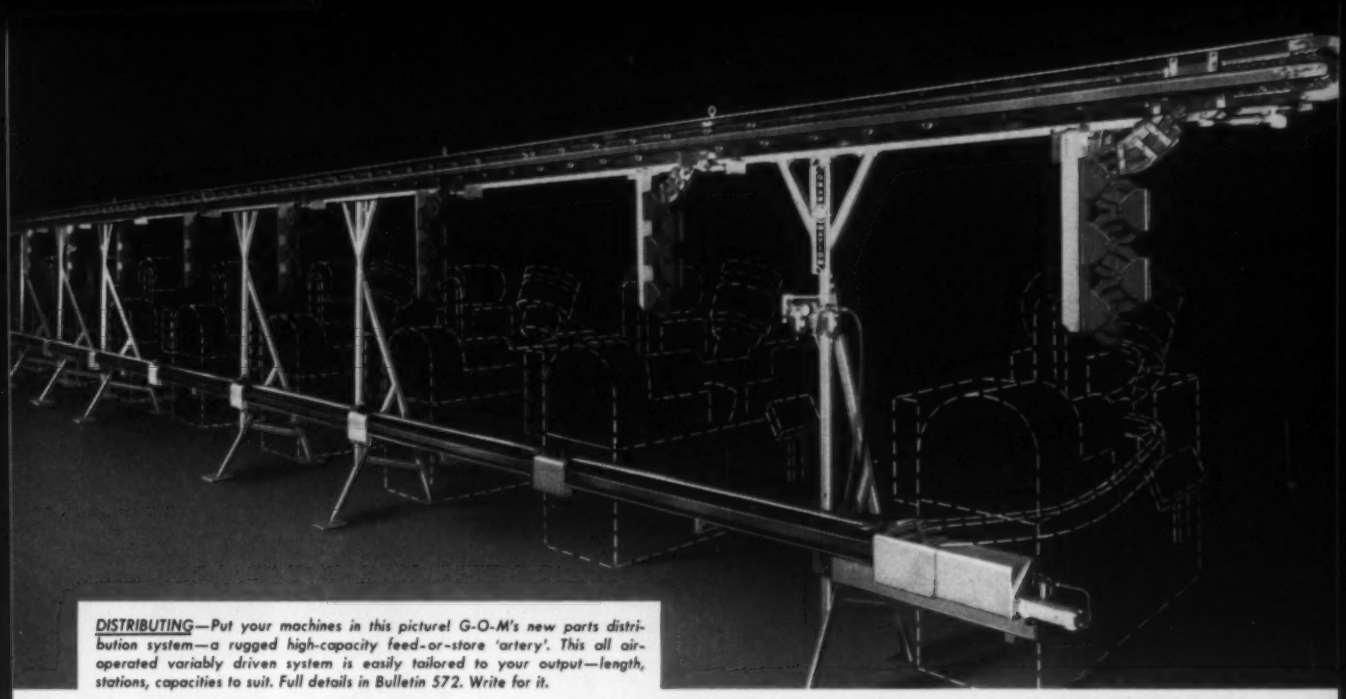


DISTRIBUTING—Put your machines in this picture! G-O-M's new parts distribution system—a rugged high-capacity feed-or-store 'artery'. This all air-operated variably driven system is easily tailored to your output—length, stations, capacities to suit. Full details in Bulletin 572. Write for it.

Automatic parts-handling units...

...pre-engineered to cost you less

STORING—or feeding parts on demand is easy with G-O-M's latest storage unit. Capacity: 1500 to 3000 parts, depending on size. This rugged unit has 'by-pass' track, built-in counters and many other exclusive features. Send for descriptive Bulletin 573.

Whether you're automating a single machine or a full line, Gear-O-Mation has the pre-engineered equipment to do the job—properly and inexpensively. Automatic parts handling is G-O-M's specialty—its *only* specialty. G-O-M equipment is now controlling and moving all kinds of parts—from small blanks to heavy castings. And slashing costs while doing it with standard (but readily adaptable) units.

If your process requires demand control, selective feeding, active storage or positive movement of parts, try automation by Gear-O-Mation first.

WASHING—and drying of all kinds of parts can now be done automatically with washers from G-O-M's extensive line. Newest addition: 'off-the-floor' washers to be set in-line with overhead parts-handling systems. Ask for Bulletin 574.

Circle 703 on Page 163

automation by

GEAR-O-MATION

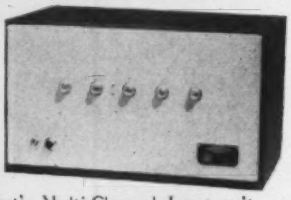
DIVISION OF MICHIGAN TOOL COMPANY

7171 E. McNICHOLS ROAD • DETROIT 12, MICHIGAN

WASHERS • STORAGE UNITS • ELEVATORS • SKEW LOADERS • BASKET LOADERS • DISTRIBUTION SYSTEMS
DEMAND FEEDERS • MACHINE LOADERS AND UNLOADERS • ORIENTORS • SIZE CLASSIFIERS
HOPPER FEEDERS • ASSEMBLY DEVICES AND SPECIAL EQUIPMENT

Post Decitron
electronic products

Model MC

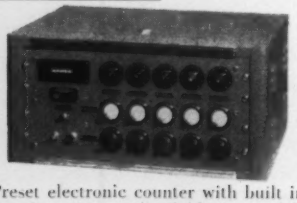


Post's Multi-Channel Input unit . . . accumulates "counts" from several different production lines where total count is desired, utilizes separate photoheads for each line. Anti-coincidence circuit keeps count accurate even if objects on two different lines break beam simultaneously.

Model SD-IT

Outmodes all mechanical counters. Capable of operating at speeds up to 100 units per second. Single "count" indicated on the six digit totalizer as each *tenth* item breaks the light beam. Counts dozens or gross with 12 place counting tube.

Model PW-5



Preset electronic counter with built in warning system. Available in models for counts of 1-100 (PW-2) to model with range 1-100,000 (PW-5). Will count in batches. Warning device may be used to coordinate secondary circuit just before desired count is reached. Will stop machine, cut, divert or perform any other operation. Automatically resets to zero when preset number is reached.

POST ELECTRONICS

Division of Post Machinery Co.
160 Elliott St., Beverly, Mass.

Decitron

POST ELECTRONICS
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160 Elliott St., Beverly, Mass.

☐ Send literature on Model_____
☐ Please send name of nearest representative

Name_____
Company_____
Address_____
City_____ State_____

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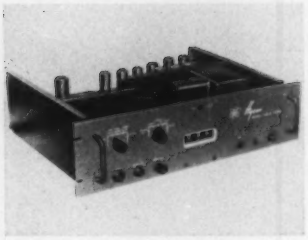

Digital Multimeters

Item 460

Device can be used in production systems to readout temperature, pressure, velocity, or any other data that can be reduced to a form involving electrical resistance, current, or voltage. An illuminated decimal point on the 3-digit display moves with the position of the range switch, eliminating multiple scale error. A red illuminated signal indicates when the next higher scale should be selected. Two models are available; one is capable of measuring a wide range of voltages and resistances; the other is used in applications where extreme accuracy is imperative. **Hycon Electronics Inc.**, 321 S. Arroyo Parkway, Pasadena, Calif.

Circle 460 on Page 163

Demodulator

Item 461

Instrument is adaptable for operating differential transformer transducers with standard strip chart recorders, X-Y plotters, or digitizing equipment. The unit supplies current-regulated ac excitation to the transducer, demodulates and filters the transducer signal, and supplies a linear dc output signal proportional to the transducer signal. A magnetically regulated, tubeless circuit provides reliability for critical applications plus freedom from drift. A constant current excitation system maintains constant amperes turns in the transducer primary, and a fixed transducer sensitivity. Unit is rated for 115v, 60 cycle power. **Daytronic Corp.**, 216 S. Main St., Dayton 2, Ohio.

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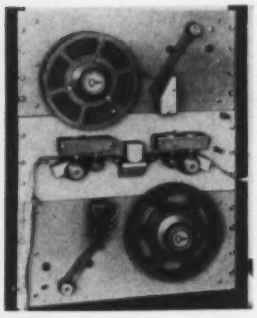

Tape Reader

Item 462

Device reads perforated paper tape strips or reels and operates at speeds up to 750 characters per second, with less than 5 millisecond start or stop time. At 300 characters per second it stops in the space following the stop character; for 750 character per second operation, a two character stop space is recommended. Tape reader provides remote control of forward, reverse, stop, and speed change. If the tape is improperly threaded, a sensing unit prevents operation. The handler has bidirectional operation for both reels and strips, and a positive timing belt reel drive. **Digitronics Corp.**, Albertson Ave., Albertson, L. I., N. Y.

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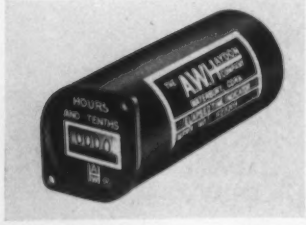

Time Indicator

Item 463

Sub-miniature hermetically sealed elapsed time indicator has 400 cycle motor, operates on 115v. The five-digit counter totalizes to 9999.9 hours. The first four digits read whole hours, and the last digit,

air circuitry:

a new term of importance to control engineers.

Air has come of age as a control medium. No longer is it confined to the simple jobs of pushing a clamping device, moving a lever, or blowing chips. No longer is an air circuit just a valve, reservoir, and cylinder. Today the most complex of industrial control problems can and are being solved efficiently with air.

Today, pneumatic circuits can be interconnected. They can be set to control a complex sequence of operations *automatically*. They can be combined with electrical circuits. There is *no* control problem you have that can't be solved successfully with air.

The new role that pneumatic control can play in industrial operations demands a new way of thinking about air control. It demands a new way to describe control by air—a new name that suggests some of its limitless control possibilities. That's why Westinghouse Air Brake Company is now using the term "air circuitry" to describe the application of air control to automation.

Westinghouse Air Circuitry, we realize, has to be more than *just as good* as your present means of control. It has to offer you *extra advantages*. And it does.

Chief among these is its extreme simplicity. The devices themselves are uncomplicated mechanical devices. They have few moving parts. They are easy to service by any mechanic. The circuit connections are made with pipe—and what could be simpler than that!

This extreme simplicity brings with it other important "pluses" for air circuitry. The simple equipment is unusually reliable—there are few moving parts to wear out or get out of adjustment. The devices are sturdy and durable. They require very little maintenance. What maintenance there is can be handled without the services of highly trained technicians.

Above all, remember: no means of control is as *safe* as air.

Air circuitry can help you simplify your control problems. It can help you get accurate answers to your automation problems on any industrial machine . . . in any industrial process. And Westinghouse Air Brake Company can help you with the engineering of a suitable system. Westinghouse has been in the control engineering business for 80 years now. It has been at the forefront of the development and improvement of air control equipment and its applications.

For more information on Westinghouse Air Circuitry—how it has helped other companies, how it can help you—write for your copy of "Basic Pneumatic Control," or call our nearest sales office.

WESTINGHOUSE AIR BRAKE COMPANY, INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PA.

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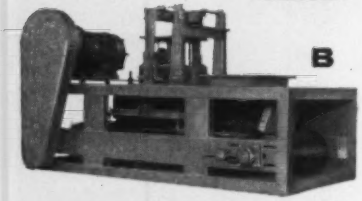
UNITIZED

WEIGHER-FEEDER

Building-block design gives custom-made utility at an off-the-shelf cost



UNITIZED construction makes the W-C Weigher-Feeder readily adaptable to practically any processing setup. Components are standardized, proven and interchangeable . . . pre-engineered with virtual "plug-in" simplicity.

A The UPPER FRAME controls material input, is supplied with a rotary feeder, sliding gate, vibratory feeder or other mechanism matched to material and flow requirements.

B The CONVEYOR FRAME, where material is weighed, includes a complete conveyor section, weighing pan and transmitter with integral tare adjustment. W-C's system of flexure mountings assures accurate measurement despite uneven loading or pile-ups. There are no knife-edges, beam pivots or other points of concentrated wear to affect accuracy.

C The LOWER FRAME is optional; can be a simple chute as shown.

In addition, the W-C Weigher-Feeder is designed to handle such instrument-controlled functions as flow totalizing, recording, programming, and material proportioning. Units are also available for installation on existing conveyors.

Complete information is given in Catalog 12. Write for a copy

W-C

S.A. 1667

WEIGHING and Control COMPONENTS, Inc.

206-C Lincoln Ave., Hatboro, Pa.

Circle 706 on Page 163

color coded red, reads tenths of hours.

Also available is an indicator which uses a dial with two hands. The sweep hand reads to 100 hours in 5 hour increments, and the color coded totalizer hand reads to 2,500 hours in 100 hour increments. An operation indicator on the face of the unit allows calibration checking during operation. **A. W. Haydon Co.**, Waterbury, Conn.

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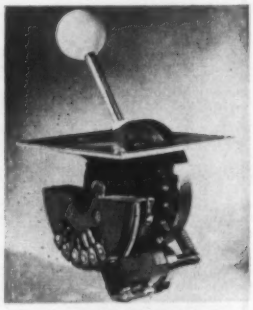

Selector Switch

Item 464

Designed for use in sawmill setworks controls, selector switch is also suitable in any electrical installation requiring heavy duty controls. All motion is either to or from the operator. Built-in self-wiping contacts provide long life and positive contact. Model shown has 6 contacts, others are available with from 4 to 10 contacts. **Sel-Set Machinery Corp.**, 290 Moyer Lane, Salem, Ore.

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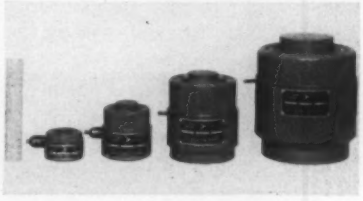
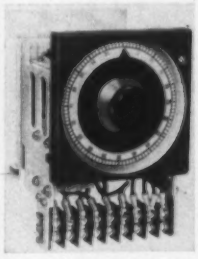


Load Cells

Item 465

Device is suitable for electrical measurement of forces and weights. Precision strain gage load cells provide up to 250 per cent greater output and reduce interference from stray signals. Units are available in nine capacities from 500 to 200,000 lb. Cells are constructed to allow 225 per cent overload without affecting calibration. The cable cell has a stainless steel jacket and does not absorbe moisture. **Cox & Stevens Electronic Scales Div., Revere Corp., of America**, Wallingford, Conn.

Circle 465 on Page 163



Add-Subtract Counter

Item 466

Counter can add or subtract pulses in any sequence, providing automatic control for conveyor systems, inventory systems, and storage hoppers. Add pulses over one circuit advance the counter counterclockwise to a preselected maximum set on the dial, where an integral load switch is actuated. This switch can be connected to stop a motor, energize a valve, ring a bell, etc. It can also be used to cut off the add pulse to stop further counterclockwise dial rotation until at least one subtract pulse has been received. Subtract pulses over a second circuit return counter dial clockwise towards zero where integral zero switch is actuated.

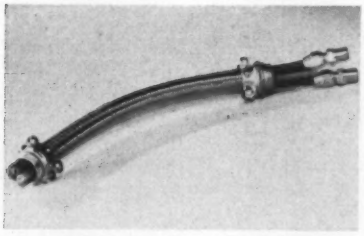
Wired for continuous count, the unit will also receive add or subtract pulses continuously at rate of 100 pulses per revolution. With the maximum switch set at 50 on the dial, an output pulse will be secured for every 50 input pulses. Special cams are available for 5, 10, 20, and 25 counts per output pulse. Counter is rated 115 or 230v, 60 cycles, and has 10-amp contacts. **Eagle Signal Corp.**, Moline, Ill.

Circle 466 on Page 163

Tube Trunk

Item 467

Made in any specified length up to 1000 ft, multitube trunk is suitable for use in the chemical processing, petroleum, and pulp industries. Trunk consists of a group of color-coded Plaskon Nylon tubes



gathered in a braided stainless steel sheath. This construction provides resistance to corrosive conditions and has an ability to contain high pressures for prolonged intervals at temperatures up to 250 F. Unit is adaptable for any completely self-contained system which uses a combination of services such as air, hydraulic oil, lubrication oil, and electrical lines. **M & Q Plastic Products,** P. O. Box 402, Freehold, N. J.

Circle 467 on Page 163

Speed Reducer

Item 468

Device is available for a ratio of 5 to 1 in a single reduction and ratios of 14 to 1 or 25 to 1 in double reductions. Unit ratings range from 2 hp at 5 rpm to 50 hp at 359 rpm. Maximum torque rating at low speed shaft is 31,000 lb-in. A longer center distance between shafts permits use of larger sheaves on installations where unit is mounted with input shaft toward driven machine, or on through-shaft applications. An automotive type dip stick is provided for a quick check of oil level. **Falk Corp.,** Dept. 255, 3001 W. Canal St., Milwaukee 1, Wis.

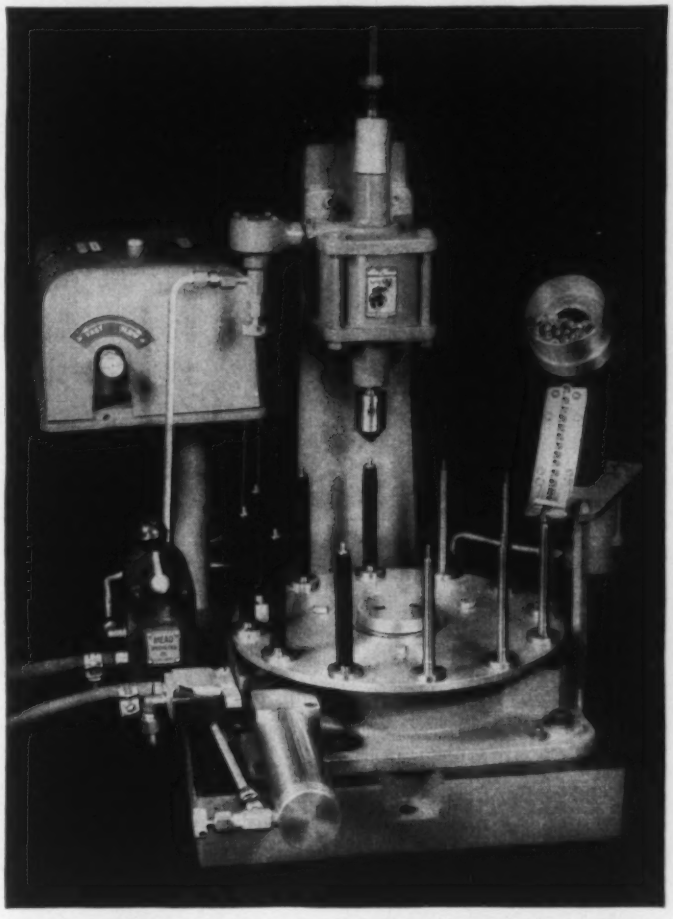
Circle 468 on Page 163

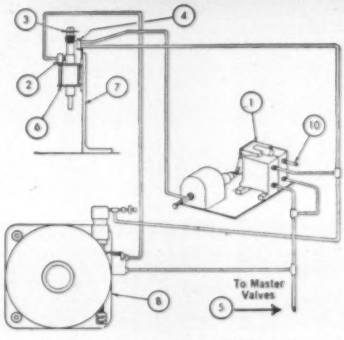
Differential Drive

Item 469

Unit contains two ac or dc motors and a precision gearing arrangement. Output shaft rpm is the algebraic sum or difference of the speeds of the two motors. Typical performance is from 5 rpm clockwise, through

Automation With Air Power

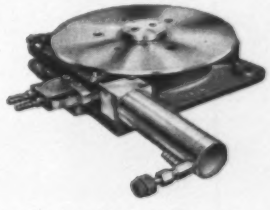




Circuit Diagram of Units in This Photo

Combine readily to feed work to drill press, air impact hammer for a wide variety of operations.

MEAD Rotary Work Feeder is the heart of this machine to crimp eyelets and rings on pen barrels. A simple combination of standard Mead units makes a semi-automatic machine—operator merely loads.



The ROTARY WORK FEEDER indexes to 8, 12 or 24 stations, at speeds from 15 to 150 stations per minute. Auxiliary valve actuates drill press feed or other pneumatic tool as each station indexes.

(1) Meadmatic Timer controls cycles per minute and "dwell". (2) Speed control valve and quick exhaust valve regulate advance and retraction of tool. (3) Adjustable depth stop. (6) Single-acting air cylinder. (7) Vertical stand. (8) Rotary Work Feeder. All units mounted on Universal Base.

MEAD

Write for free booklet of 44 "Examples in Air Power Automation".

SPECIALTIES COMPANY, 4114 N. Knox, Dept. A-48, Chicago 41, Ill.

PATHFINDER IN AIR POWER AUTOMATION

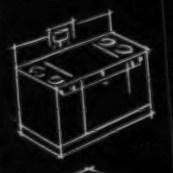
Circle 707 on Page 163

Sockets for HEX head

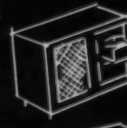
¼"-9/32"-⅜"-½" sq. dr. sheet metal screws

USE THESE SOCKETS WITH HARDENED SCREWS DRIVEN INTO TAPPED HOLES, NUTS, ETC.		USE THESE SOCKETS WITH HARDENED SCREWS THAT TAP THEIR OWN THREADS				
SINGLE HEX	MAGNETIC	SINGLE HEX	MAGNETIC	OVERALL LENGTH		
PART NO.	PART NO.	PART NO.	PART NO.		TYPE	BROACHED OPENING
1E06	M1E06				A	3/16
					A	7/32
					A	1/4
					C	1/4
					A	9/32
					B	9/32
					B	5/16
					B	11/32
					B	3/8
					B	7/16
					B	1/2
					A	3/16
					A	7/32
					A	1/4
					A	1/4
					A	9/32
					C	9/32
2I					B	5/16
2I					B	11/32
2E					B	3/8
2E					B	7/16
2E					B	1/2
3E					A	3/16
3E					A	7/32
3E					A	1/4
3E						9/32
3E1						5/16
3E1						11/32
3E12						3/8
3E14						7/16
3E16						7/16
3E18						1/2
						9/16
5E08						1/4
5E09						9/32
5E10						5/16
5E11						11/32
5E12						3/8
5E14						7/16
5E16						1/2
5E18					B	9/16

hex head screws are used to fasten just about everything!



and just about everyone uses APEX sockets to fasten hex head screws!

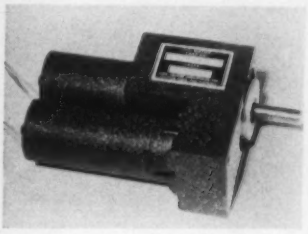


write, on your company letterhead please, for your copy of APEX Catalog 29-R.

1933 *A Quarter Century of Service to Industry* 1958

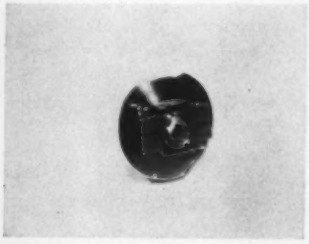
THE APEX MACHINE & TOOL CO.
1036 S. Patterson Blvd.
Dayton 1, Ohio

TOOLS FOR screwdriving nut running FASTENING



zero rpm to 5 rpm counterclockwise with 300 oz-in. of torque. Speed range may be up to 100 rpm in either direction. Torques to 2500 oz-in. are possible with smooth changes through zero at full torque. **Globe Industries Inc.**, 1784 Stanley Ave., Dayton 4, Ohio.

Circle 469 on Page 163



Adjustable Cam Assembly

Item 470

Model T-159 is adaptable for use in servo mechanisms to actuate switches and similar devices at predetermined angular limits. Two stainless steel cams can be rotated relative to each other to permit adjustment of rise length from 180 to 360 degrees. A balanced clamp secures the assembly to the shaft as well as locking the cams for the desired setting. Maximum diameter is 1⅛ inch. Hubs are available for ⅛, 3/16, and ¼ inch shafts. **Sterling Precision Corp.**, 54-17 Lawrence St., Flushing 54, N. Y.

Circle 470 on Page 163

Pressure Switch

Item 471

Line of pressure switches is suitable for the chemical and processing industries. Switches are available

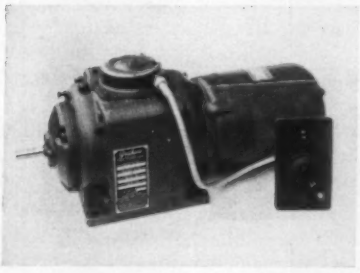
in materials for use with concentrated hydrogen peroxide, fuming nitric acid, liquid oxygen, proprietary amine fuels, fluorine, and mixtures of fluorine and liquid oxygen. Proof pressures are from 224 to 6000 psi; pressure settings from 2 to 4800 psi. Switch can operate in temperatures from −65 F to +275 F. Single pole, double throw switching elements are rated to 10 amps, for ac and dc circuits. A safety feature includes a housing which serves as a pressure tight safety capsule in case of a break in the sensing element. **Pressure Switch Div., Barksdale Valves,** 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 471 on Page 163

Remote Control

Item 472

Control unit for variable speed drives permits accurate remote settings of speeds for machine tool feeds, feeder and pump rate settings, and proportioning controls. The re-



mote control can be panel mounted and connected to the variable speed drive at a convenient part of the machine. There are 100 divisions for each turn of the control crank with one number on the counter for each turn of the crank handle. A knob may be turned to lock the crank against rotation.

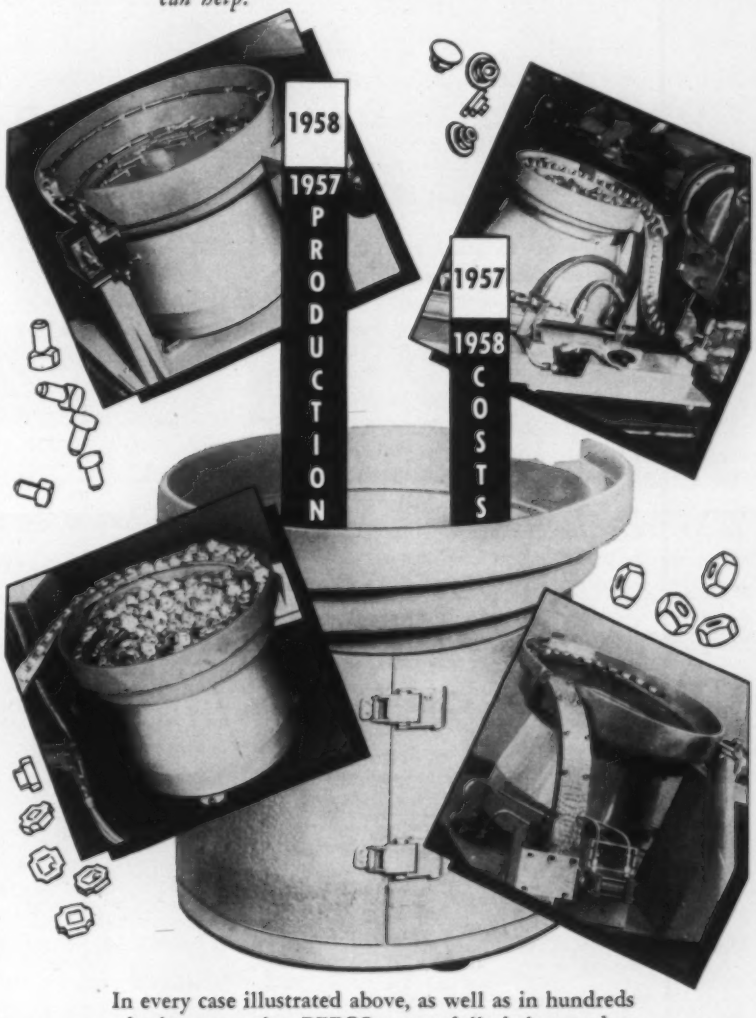
The transmissions can be furnished with a remote micrometer control; a standard micrometer control at the transmission; a lever type control shaft for operation by solenoid, or foot pedal; a pneumatic control; a remote electrical control with pushbutton or dial type controller, or automated control in adjustable proportion to a 3 to 15 psi air signal or 0.5 to 5 ma signal. Control is designed for use with drives in sizes from 1/12 to 3 hp. **Graham Transmission Inc.,** Menomonee Falls, Wis.

Circle 472 on Page 163

the shortest route to MORE PROFIT

. . . produce MORE in 1958!

If you can reduce costs while producing more, the job is twice as easy. This is where PEECO can help.



In every case illustrated above, as well as in hundreds of other examples, PEECO successfully helps production men reduce their costs by producing more—automatically.

If your equipment, machinery, production or assembly line is *not* now using parts feeders the chances are your costs are too high. Let a PEECO Sales Engineer give you the facts. He'll gladly help you without obligation. Write for literature and name of representative near you.

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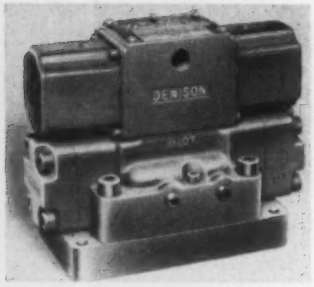
Circle 709 on Page 163



4-Way Valve

Item 473

Pilot-operated, solenoid-controlled valve is designed to provide all porting and positioning arrangements on circuits up to 3000 psi. Unit is shorter in over-all length, has internal retaining cords to secure covers to valve body. A choice of spool types and spool positioning provides combinations for a wide range of applications. Adjustable pilot chokes for smooth spool reversal are optional features. Capacities are 30 gpm for the ¾-inch pilot and 5 gpm for the ¼-inch solenoid valves which make up the composite valve. **Denison Engineering Div., American Brake Shoe Co.,** 1160 Dublin Rd., Columbus 16, Ohio.

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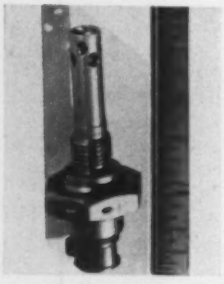


Resistance Thermometer

Item 474

Applicable in the instrumentation field, precision type instrument uses a deposited platinum film construction. Transducer has a high speed of response, can withstand extremes of both vibration and pressure. It has a base resistance up to 10,000 ohms, with ranges from −370 to +500 F. Sensing element is ⅛ inch in diameter, and 0.030 inch thick. **Nacimo Products Inc.,** National City, Calif.

Circle 474 on Page 163

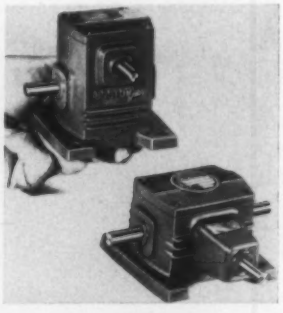
Electronic Relay

Item 475

Designed for rugged industrial applications, heavy duty electronic relay is capable of receiving a large variety of input signals at low power levels and controls up to 5 amp loads on signals of milliwatt range. An internal slide switch controls the automatic or manual reset and provides a fast recycling rate. Relay is

encased in a steel housing, with knock-outs for easy installation and panel mounting. Input power is 115 v, 50/60 cycles, 15 w; output switching is spdt rated 5 amp noninductive. **Datascan Inc.,** 48 Notch Rd., Little Falls, N. J.

Circle 475 on Page 163



Speed Reducers

Item 476

Line of small-size speed reducers for light duty applications features high power transmitting efficiency and space-saving design. Model R113 is actually a 1 to 1 ratio right angle drive. Rated output ranges from 0.03 to 0.333 hp. Two reducing units have worm gear assemblies. Model T109 is designed with the worm gear over, and Model U109 has the worm gear under. Ratios for both range from 5 to 1 to 30 to 1, and output is from 0.03 to 0.08 hp. **Boston Gear Works,** Quincy, Mass.

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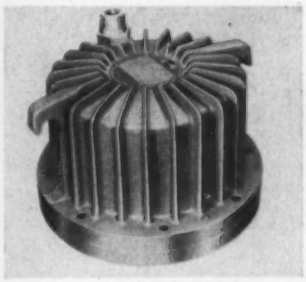
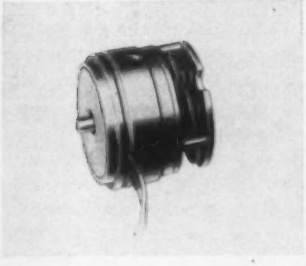


Immersible Motor

Item 477

Line of immersible motors is designed to be close-coupled to pumps and operates submerged in water, chemicals, or abrasive industrial cutting oils. The pump impeller is attached directly to the motor shaft, eliminating the need for couplings, shafting, and intermediate bearings. Unit features equalized pressure. Two or more neoprene diaphragms installed in the lower bearing bracket are exposed to the same external pressure as the shaft seal, equalizing the internal and external pressure. Motor is designed to operate continuously at rated load with a temperature rise not to exceed 55 C when completely submerged in liquids with an ambient of 40 C or less. It is available in ratings from ¾ to 40 hp for 208, 220, 440, or 550 v, 3 phase, 60 cycle and ¾ to 5 hp in 115 or 230 v single phase. **Louis Allis Co.,** Dept. P., 427 E. Stewart St., Milwaukee 1, Wis.

Circle 477 on Page 163



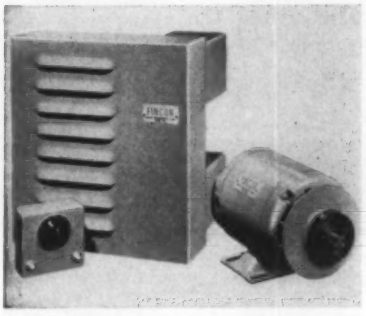
Servomotor Gearhead

Item 478

Device is applicable in positioning and computing mechanisms which require fast approaches, but slower zeroing or synchronizing action. Model X-544 is a two speed precision servomotor gearhead in a single package. The unit changes ratios internally when dc voltage

is applied to, or removed from, an actuating solenoid. Designed for integration with sizes 11, 14, or 18 motors, the gearhead requires 0.008 oz-in. of starting torque, and will operate 12 oz-in. of load torque. Operating at the higher ratio, the assembly features a backlash maximum of 1 degree with a 5 oz-in. reversing load. **Bowmar Instrument Corp.**, 8008 Bluffton Rd., Ft. Wayne, Ind.

Circle 478 on Page 163

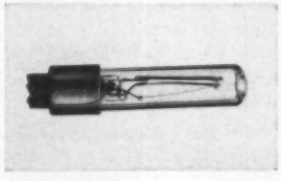


Variable Speed Drive

Item 479

Package includes an ac motor, a frame, a built-in tachometer to sense motor speed, and a magnetic-amplifier speed controller. Speed range can be provided to fit specific needs. Features of the unit include dc plugging for time-controlled braking, controlled acceleration; push-button for start-stop; overload protection; and a control to hold speed stable at the specified setting. Unit is essentially a constant-torque drive with power output proportional to motor speed. Motor-speed control package is available in 1/6, ¼, ⅓, and ½ hp sizes for operation on 220 v ac. **Fidelity Instrument Corp.**, 1000 E. Boundary Ave., York, Pa.

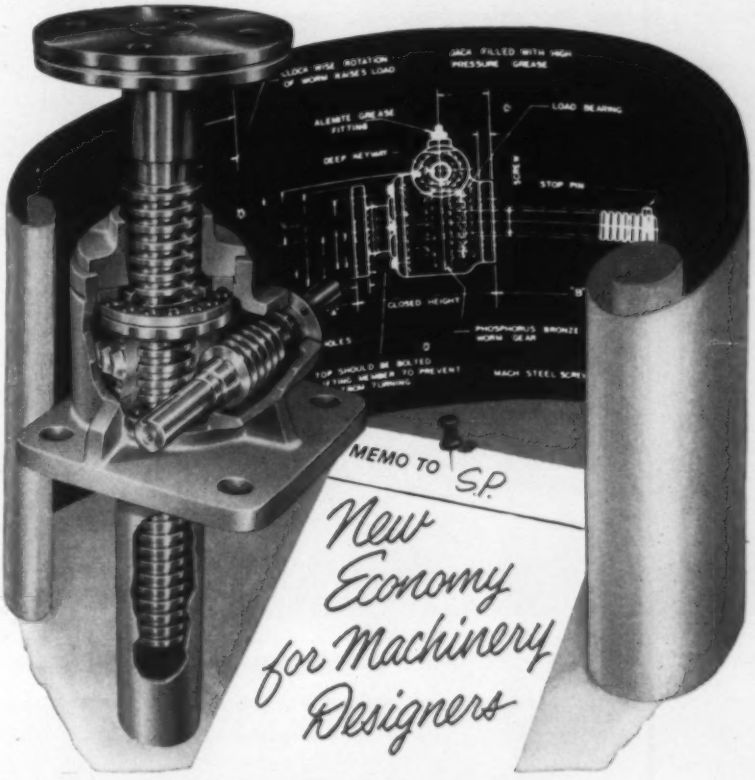
Circle 479 on Page 163



Thermal Relay

Item 480

Device is adaptable as a small voltage change detector, an under or over current or voltage indica-



NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-GG, which includes drawings and full specifications.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet, Screw,
Hydraulic, Worm Gear

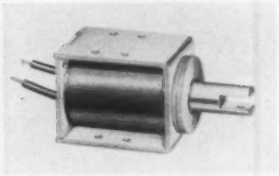
DUFF-NORTON

COFFING HOISTS
Ratchet Lever
Spur Gear, Electric

Circle 711 on Page 163

tor, or a variable time delay. Model TR-103 handles power requirements ranging from 0.050 w to 0.004 w of dc, ac, or rf. Actuating voltage is 0.4 to 0.5 v. Operational differential voltage is 0.02 v; contact rating 1 amp at 115 v ac resistive load. Relay is sealed in a glass vial eliminating contamination or oxidation of parts and providing visual inspection of contacts. **Hamlin Inc.**, 1316 Sherman Ave., Evanston, Ill.

Circle 480 on Page 163

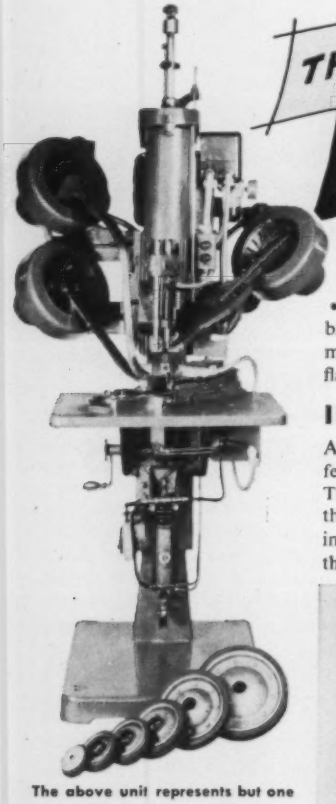


Solenoid

Item 481

Unit is equipped with a ½-inch diameter tapered plug and plunger and is suitable for use on computers, counters, automatic timers, and cycling devices. Lift of the solenoid is up to nine pounds; plunger stroke is adjustable from 1/32-inch to ¾-inch. The plunger has a slotted end with ⅛-inch diameter holes for coupling. For increased power efficiency, two 3/32-inch steel washers are welded to the front of the field piece. Unit is available in ratings from 6 to 230v, 60 cycles ac or dc, in intermittent and continuous duty types. All dc units are also available for 400 cycle operation. **Guardian Electric Mfg. Co.**, 1621 W. Walnut St., Chicago 12, Ill.

Circle 481 on Page 163



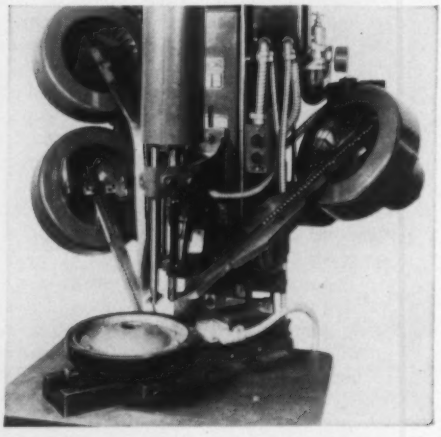
THIS 4 in 1 DPS POWER OPERATION

BOOSTS ASSEMBLY PRODUCTION 300%

• A special assembling machine built on the combination of a Power Screwdriver and three automatic Parts Feeders fastens an inner and outer flange on the rubber tires of

INDUSTRIAL TRUCK WHEELS

A screw, lock washer and nut are automatically fed and oriented, each from a separate parts feeder. The operator simply places the wheel segments in the locating fixture, starts the machine cycle indexing to the proper driving point, at which location the assembly is completed.

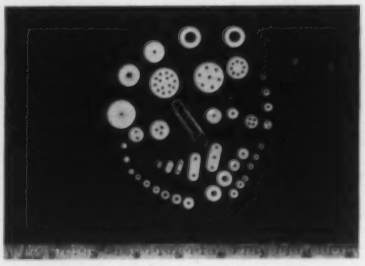


The above unit represents but one of a thousand different applications of DPS assembling machines now in successful operation. Let us show you how you can greatly increase your production at a substantial saving by these modern power methods.

DETROIT POWER SCREWDRIVER CO.

WRITE FOR CATALOG
SEND SAMPLE ASSEMBLY

2811 W. FORT ST. DETROIT 16, MICH.



Epoxy Preforms

Item 482

Units are capable of bonding metal parts and studs to all types of ceramics such as glass, porcelain, steatite, alumina, mica, quartz, and ferrites; can also hermetically seal electronic components such as diodes, resistors, capacitors, and transformers. All preforms are made to specific needs. In operation, the parts are assembled with the preforms and heat is applied. At 120 F, the preform softens and at 248 F, becomes liquid. After it flows, the joint is cured. In mass production, the assemblies pass continuously from preheat, through the flow temperature zone, then through a higher temperature cure zone. Heat can also be applied by torch, resistance, or induction methods. **Duramic Products Inc.**, 262-72 Mott St., New York 12, N. Y.

Circle 482 on Page 163

Conveyor Lubricator

Item 483

Model 114X automatically lubricates single or double chains of slat type conveyors. Air enters the lubri-

cant reservoir through a regulator. Lubricant is carried through manifolds to outlet nozzles which direct a spray of oil fog to the wheels and chain link pins. The mechanism is actuated by wheels or link pins passing the lubricator. Valve opens by cam action and oil fog is carried to points of lubrication. **J. N. Fauver Co. Inc.**, 51 W. Hancock, Detroit 1, Mich.

Circle 483 on Page 163

Thyratron Grid Drive

Item 484

Device is applicable for compact reversible motor drives for numerical control of machine tools, electronic reversing of 3-phase induction motors, and accurate feed control of clutch and brake ac motor drives. The full wave, medium gain thyratron grid drive incorporates a fast response magnetic amplifier to provide a complete servo amplifier for power levels up to 15 kw, when used with appropriate thyratrons.

In a push pull operation, a polarity reversible dc input signal controls two sets of two thyratrons each in full wave or back to back connection. Either set fires smoothly from *Off* to full *On*, depending on polarity of input signal. The unit provides a 6 millisecond response time for rapid reversing in high performance servo systems. An external resistor provides complete adjustment of null point crossover. Features of the drive include linear

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BAKER BASIC HYDRAULIC SLIDES

CHECK HERE	WIDTH OF WAYS	CAPACITY HP MAX.
( )	11	5
( )	12	15
( )	18	15
( )	18	25
( )	20	50

( ) Drive box for above slide
( ) Porta-Pak hydraulic power unit
( ) Standard index tables

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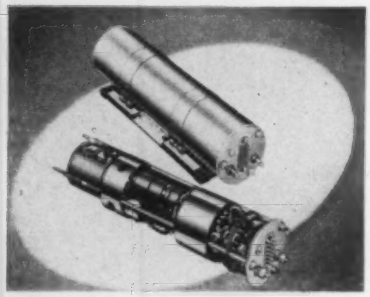
proportional control, a full 180 degree range of firing angles, inherent noise filtering, automatic compensation for line voltage variations, and elimination of variations due to aging or tube replacement. **Fairfield Engineering Corp.**, 934 Hope St., Springdale, Conn.

Circle 484 on Page 163

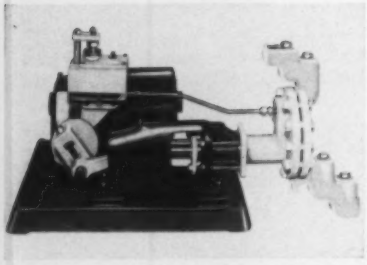


Telemetering Converter

Item 485

Instrument accepts analog signals from sensing devices such as temperature probes, pressure transducers, potentiometers, or synchros, or coded discs. These are shaft driven through a precision gear train at a ratio of 100 to 10 to 1 with respect to one another. Thus, one output will have a range for 100 per cent change input, the second a range for 10 per cent change, and the third for 1 per cent. With input impedances as high as 100,000 or 200,000 ohms, system error is held to ± 0.04 per cent. **G. M. Giannini & Co.**, 918 E. Green St., Pasadena 1, Calif.

Circle 485 on Page 163



Controlled Volume Pump

Item 486

Capable of metering toxic, obnoxious, or corrosive chemicals, pump features a Teflon diaphragm sealing the liquid end from the plunger and housing. The plunger displaces hydraulic fluid which in turn strokes the diaphragm to impart pumping action through double ball checks. Pump has an accuracy of ±1 per cent. Unit is available with maximum capacities from 1.1 to 138 gallons per hour and pressures to 2000 psi. With automatic capacity adjustments, pump is suitable for chemical instrumentation systems. **Milton Roy Co.**, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

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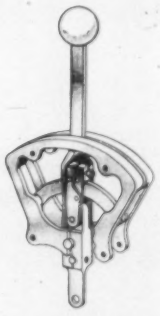

Locking Control

Item 487

Unit is applicable for locking lever controls on food processing equipment, valve locks, chemical batch processing, or other positive locking requirements. Three prime elements make up the lock; two locking shoes, one for each direction, and a quadrant. The locking device positively holds control settings, eliminates backlash and creepage. The load lever is always locked and the control lever always free. Control can be instantly repositioned with the application of light, uniform pressure on the control lever.

Forces applied at the load or driven lever produce a couple and increase shearing action on the quadrant between two shoe pins. Forces applied in the opposite direction have the same locking action on the opposite shoe, providing an irreversible lock in both directions. Force applied at the control or driving lever unlocks the shoe pins by slightly rotating the shoe plate on its axis and causes the pins to move rapidly away from the quadrant. When control force is released, the shoe is returned to its normal locked position by a compression spring. **Reid Metal Products Inc.**, 2021 N. Lincoln St., Burbank, Calif.

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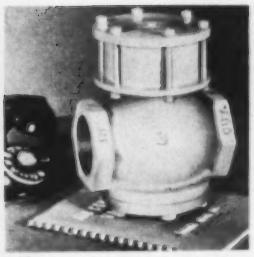

Two-Way Valve

Item 488

Suitable for use with air, oil, or water for vacuum or pressures from zero to 500 psi, pilot operated valve provides flexibility of remote control. Remote control operation is accomplished on the fluid principle of balanced and unbalanced flow line pressure. When the pilot pressure and line pressures are equalized, the poppet piston closes. Static line pressure assures positive tight shut-off. Valve has only one moving part, a bubble-tight shut-off; is noncorrosive; and is available in pipe sizes from 1½ to 3 inches. **Airmatic Valve Inc.**, 7317 Associate Ave., Cleveland 9, Ohio.

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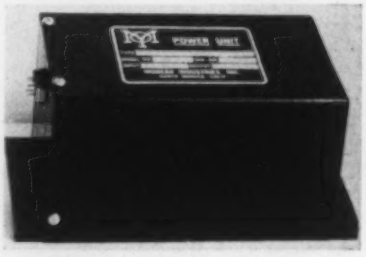

Power Supply

Item 489

Developed for use with strain gages and transducers related to telemetering instrumentation, transistorized power supply is also suited for missile and aircraft applications. Model MIC-5-1R operates from a nominal 28v dc input, and supplies 5v dc at zero to 1 amp at the output. The regulation is better than ±1 per cent for line changes of 26 to 30v, and for load variations from no load to full load. The same regulation is obtained over an ambient temperature range from −55 C to +71 C. **Modern Industries Inc.**, 2601 Colorado Ave., Santa Monica, Calif.

Circle 489 on Page 163

AUTOMATION new books

PROCESS INSTRUMENTS AND CONTROLS HANDBOOK

Edited by Douglas M. Considine; 1286 pages, 6 by 9 inches, illustrated, clothbound, published by McGraw-Hill Book Co., New York; available from AUTOMATION; *$19.50 postpaid.*

Comprehensive reference book was prepared by a staff including 71 specialists. Sections cover in detail the methods for measurement of temperature, pressure, flow, level, and chemical composition. Also discussed are indicating and recording instruments, automatic controllers, and control valves and actuators. Final sections cover principles of automatic control, reference data, and a glossary of terms. Chart inserts are included showing general application limits, physical techniques used, and practical instrumentation considerations for 104 different instruments or techniques.

ENGINEERING MANPOWER—HOW TO IMPROVE ITS PRODUCTIVITY

By graduate students at Graduate School of Business Administration, Harvard University; 162 pages, 8½ by 11 inches, paperbound; available from Engineering Management Reports, P. O. Box 161, Cambridge 38, Mass.; $18.50.

Report records philosophies, policies, and practices with regard to technical personnel as found by survey. Comments are noted on factors such as organization of engineering departments, planning, hiring, training, working conditions and equipment, supporting personnel, compensation, and patent arrangements. In a final section the authors give their conclusions and suggestions for improved productivity.

BASIC AUTOMATIC CONTROL THEORY

By Gordon J. Murphy, assistant professor of electrical engineering, University of Minnesota; 557 pages, 6 by 9 inches, clothbound, published by D. Van Nostrand Co. Inc., Princeton, N. J., available from AUTOMATION; *$9.00 postpaid.*

Basic text on theory for the analysis and synthesis of linear control systems is based on courses taught at the University of Minnesota. Definitions of terms, characteristics of common control-system components, and mathematical background are included. Use of block diagrams and signal flow graphs is explained and methods of classifying systems as to type are discussed. Detailed discusions are presented on stability, ultimate-state response, frequency response, and time response. Problems are included to supplement the text.

INSTALLING ELECTRONIC DATA PROCESSING SYSTEMS

By Richard G. Canning, Canning, Sisson and Associates; 193 pages, 6 by 9 inches, clothbound, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$6.00 postpaid.*

This book discusses factors in the installation of electronic data processing systems after the order is placed for the equipment. A previous book by the same author discussed activities leading up to that point. This volume on installation is based on actual experience of a number of firms with regard to planning the installation, programming, installing, converting to the EDP system, and operating it.

HOW TO READ SCHEMATIC DIAGRAMS

By David Mark; 147 pages, 5½ by 8½ inches, illustrated, paperbound, published by John F. Rider Publisher Inc., New York; available from AUTOMATION; *$3.50 postpaid.*

Elementary textbook on schematic diagrams is suitable for industrial training courses to acquaint personnel with electronic symbols and diagrams. Progressive illustrated approach requires no previous knowledge of electricity or electronics.

DESIGNING FOR PRODUCTION

By Edward N. Baldwin, manufacturing consultant, Westinghouse Electric Corp., and Benjamin W. Niebel, head, Industrial Engineering Dept. Pennsylvania State University; 645 pages, 6 by 9 inches, clothbound, published by Richard D. Irwin Inc., Homewood, Ill; available from AUTOMATION; *$8.40 postpaid.*

Text covers materials and processes and highlights considerations affecting product design. Materials discussed include ferrous metals, nonferrous metals, plastics, rubbers, ceramics, carbon, and wood. Processes covered include casting and molding, hot working of metal, cold working of metal, material removal, joining, heat treating, finishing, assembly, and packaging.

Government Publications

A Second Survey of Domestic Electronic Digital Computing Systems. *Report* PB 111996-R *by Ballistic Research Laboratories, 439 pages, available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $7.00.*

Book published for guidance of Government agencies and contractors reports on engineering and programming characteristics of 103 commercially available systems. Data is given on applications, cost, personnel requirements, power requirements, and space requirements for specific systems. Also included are comparative tables, a discussion of trends, a bibliography, and a complete glossary.

Methods of Testing Thermocouples and Thermocouple Materials. *NBS Circular 590 by National Bureau of Standards, 21 pages, available from Supt. of Documents, U. S. Government Printing Office, Washington 25, D. C.; 20 cents.*

Publication describes methods of testing, selection of a method adapted to a given set of conditions, and precautions that must be observed. Accuracies obtained by different methods and uncertainties in interpolated values are presented in a table.

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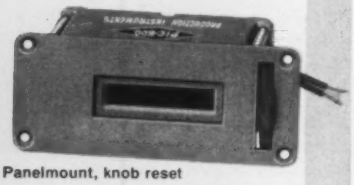

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Circle 714 on Page 163

AUTOMATION problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

Case 1427-P
Linear Speed Indicator

. . . We are most interested in obtaining information regarding speed indicating and recording equipment for speeds varying from zero to 200 inches per minute in a straight line. We do not wish to use a rotating contact and/or tachometer generator arrangement. . .

Senior Electrical Engineer

♦ ♦ ♦

Case 1471-P
Crane Weighing

. . . I would be most appreciative if you could refer me to a manufacturer of a device for weighing materials. This device must be an integral part of a crane hook, or attachable to the hook. . .

Plant Industrial Engineer

♦ ♦ ♦

Case 1472-P
Making Piston Rings

. . . Can you please tell me where I may obtain information on engineering, methods, and sequence of operations for manufacturing piston rings? These piston rings are of odd sizes and the quantities are small, but there may be justification for tooling up if the tools and equipment are not too expensive. . .

Manager

Suggestions for 1314-P (Oct. 1957)
Components for Gaging

. . . I believe that the card reader which we manufacture would be of interest . . .

Alex Sherman
Peerless Electric Co.

♦

. . . If this company is interested in automatic liquid level gaging, our company manufactures ultrasonic liquid level point sensors and companion control units . . .

Paul M. Platzman
Narda Ultrasonics Corp.

♦

. . . Beckman/Berkeley manufactures digital and analog instrumentation of the type shown in the enclosed catalog. We can supply position transducers, analog-digital converters, and digital display units or printers . . .

Edgar J. Buchs
Beckman Instruments Inc.

♦

. . . We regularly sell some of our gaging components on an OEM basis and would be pleased to discuss similar possibilities with this firm . . .

David M. Gaskill
Airborne Instruments Laboratory

♦

. . . We believe our Rototimer might be of interest as a shaft position indicator . . .

Edward B. Farmer
Farmer Electric Products Co. Inc.

♦

. . . We can be of special help to him in the fields of card and tape translators, arithmetic units, and possibly shaft position encoders . . .

Robert W. Brooks
Computer Control Co. Inc.

♦ ♦ ♦

Suggestions for 1317-P (Nov. 1957)
Reversing Motors

. . . Advise "Superintendent" to contact In-Sink-Erator Mfg. Co., 1225 14th St., Racine, Wis. They have a garage door closing unit which he should be able to use, and they own the patent on the reversing switch. . .

Tom Spackman
American Radiator & Standard Sanitary Corp.

. . . In answer to Problem Forum Case 1317-P, you may refer to the Inst-O-Herse motor of the Franklin Electric Co., 345 E. Spring St., Bluffton, Ind. . .

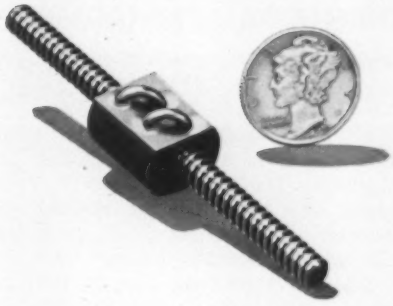
J. L. Becker
General Electric Co.

. . . We are enclosing our Bulletin 1055 and you will find the reversible motor described as Model 52 on the second page of this bulletin. . .

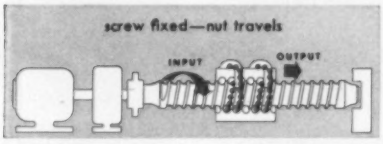
R. F. Anderson
Hagen Mfg. Co. Inc.

Here's your new ANSWER

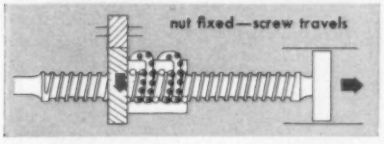
PHOTOGRAPHED ACTUAL SIZE
BALL CIRCLE DIAMETER: 3/16 inch.



WORLD'S SMALLEST ball/bearing SCREW SOLVES CRITICAL MINIATURE POSITIONING/CONTROL PROBLEMS



NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque than acme screws.



SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with unprecedented efficiency.

An unprecedented achievement in minimum size and weight—maximum efficiency, dependability and service life for ultra-precise controls.

It's another first from Saginaw—and the possibilities it opens up for improved electrical and electronic controls are limited only by your imagination! Radar tuners, missile and rocket guidance and telemetering systems, automatic switchgear, electronic machinery controls are just a few of the applications where this new miniature Saginaw b/b Screw will solve critical positioning/control problems. *It's so compact and light,* you can save substantially on space and weight. *It's so efficient,* (over 90%) you can use much smaller motors and gear boxes. *It's so precise,* you can position components within .0005 inch per inch of travel. *It's so dependable,* you can rely on remarkably long service life even in adverse environments.

You will find our 1958 Engineering Data Book extremely helpful in planning applications, or experienced Saginaw engineers will gladly make specific recommendations without obligation. Just phone, write or mail the handy coupon.

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AUTOMATION abstracts

INTRODUCING NUMERICAL CONTROL

By LEON E. LAUX
Chief, Mfg. Research & Development
Martin Co.

SUCCESSFUL introduction of numerical control into the Martin Company culminated after more than a year of careful preparation for integration of this new machine tool concept into its engineering design and manufacturing operations. Since Martin is one of the first companies in the aircraft industry to install a numerically controlled machine tool, it is felt that a description of our experience might be of interest and possibly also of aid to others who are considering its use.

First of all, the influence of numerical control on a well established and going materials processing organization cannot be overestimated. Practically every operation necessary for the transformation of an idea from the origin of a design on down through the production of a part is subject to radical change.

Being aware of this fact, an indoctrination program for all personnel who were to be engaged in materials processing for and the operation of our numerical control system was drafted and put into effect a year before the delivery of our machine. This program entailed:

1. Defining what was to be done in each and every step of the processing procedure.
2. Selecting qualified personnel for materials processing, equipment operation and maintenance.
3. Providing specialized training in computer technology and operation.

In implementing this program we realized that with a majority of our machine tools still under manual and template control it would be necessary, for the time being at least, to plan for both mediums of production. Conventional engineering drawings and processing methods could not be abolished in favor of numerical control. However, the system of dimensioning engineering drawings could be altered to permit more rapid translation of dimensions into numerical control data.

Preparing the Tape

Once the basic numerical plan is established for a particular part, the remaining steps of transforming the plan into a machine control tape are fairly routine:

1. A write-up or manufacturing plan describing, in detail, all conventional and numerically controlled machining operations and instructions.
2. Preparation of a numerical control drawing, which is a pictorial representation of the part, showing the path of the cutter and the sequence of cuts in lieu of conventional dimensions.
3. Preparation of a numerical control process sheet, containing machining data in numerical control code.
4. Preparation of the paper process tape, a Flexowriter reproduction of the data appearing on the numerical control process sheet.
5. Retyping for verification of the original process tape.
6. Feeding of the process tape data through the computer and punching of the machine control tape.

All tape preparation is accomplished in an air-conditioned, humidity-controlled room located in our manufacturing engineering office. Only the machine control tape, the write-up, and part drawing are forwarded to the shop. All other data such as the numerical control drawing, the numerical control process sheet, and the process tape are filed for future use in the manufacturing engineering office.

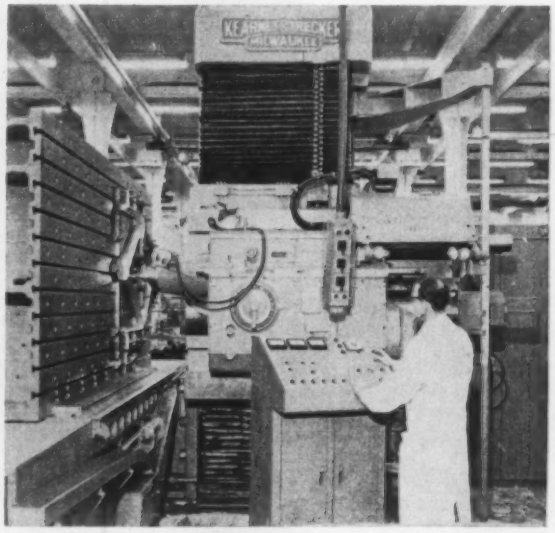


Fig. 1—Numerically controlled milling machine can mill aircraft bulkhead fittings in 2 hours instead of 8 hours required by conventional machines.

Although we presently have several different types

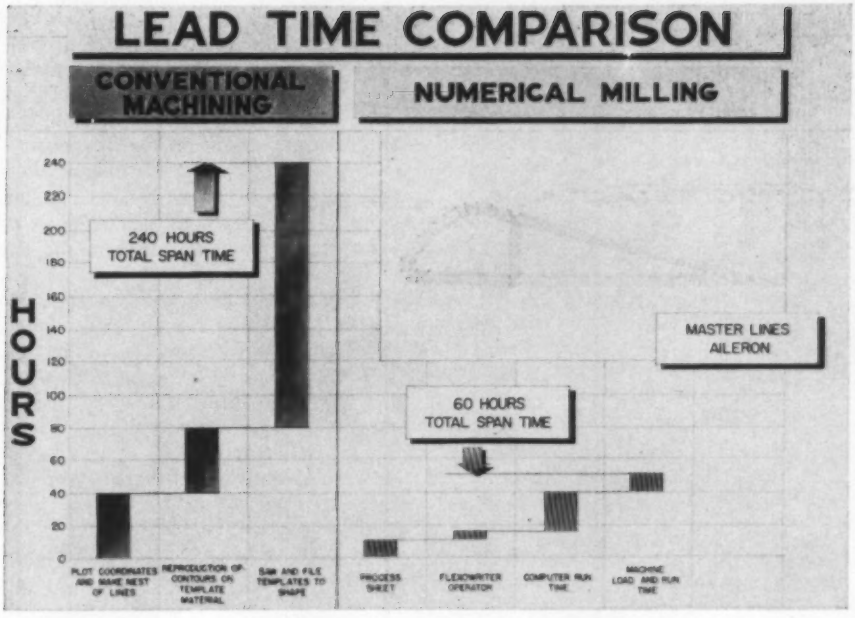


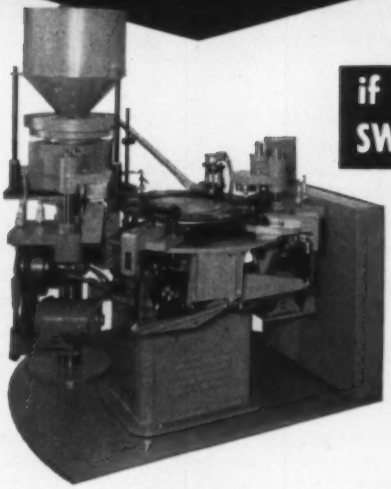
Fig. 2—Lead time for preparation of aileron master templates used for master gages and skin dummies is reduced by 75 per cent with numerical techniques.

of tape controlled machines in operation, this discussion will be limited to our experience with a three-dimension, punched tape controlled profile milling machine, *Fig.* 1. Exactly three weeks after delivery, this machine was ready for operation. During the next two weeks it was subjected to trial runs to assure the proper functioning of the machine and its control unit.

Acceptance Tests

A series of acceptance tests was devised to de-

You can get this sooner and at lower cost . . .



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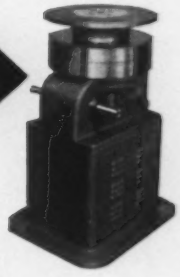

You save both TIME and MONEY on your special machines when you start with a Swanson Standard Indexing Machine Chassis. These versatile units give you a headstart on special purpose automatic machines for processing, machining and assembly operations.

When you use Swanson Standard Chassis you get all the proved and tested advantages of experience at a fraction of your "special" costs. *Write for illustrated folder.*

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AUTOMATIC ASSEMBLING AND PROCESSING MACHINES

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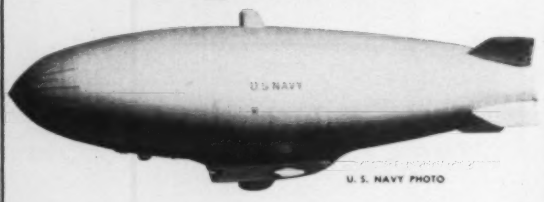
Trouble Spotter...

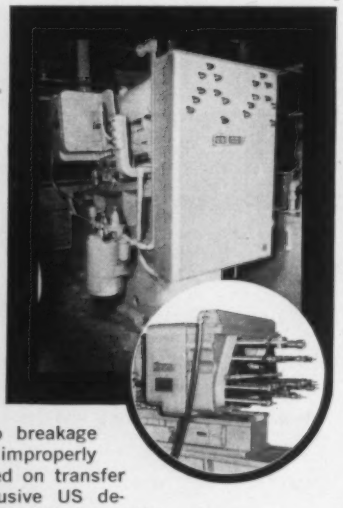


U. S. NAVY PHOTO

This majestic cruiser is a U. S. Navy airship. Its mission is locating trouble—*ahead of time*. How effective its deadly purpose in convoy is attested by the fact that "no vessel escorted by a blimp in World War II was sunk by an enemy submarine." Its invaluable contribution to our Aircraft Early Warning system is also firmly established. It is a Navy "tool" that virtually eliminates surprise.

The U. S. Drill Head Co.'s new electronic device seeks trouble too—in automated production lines. It locates faulty machining during a "transfer setup" and stops the machine *before* succeeding operations are begun. It minimizes the chance of costly smash-ups and resulting expensive down-time . . . reduces re-operating and scrap-loss costs.

It is another precision cost-reducing "tool" from the largest exclusive drill head builder in the world.



US Individual Lead Screw Tapping Head automatically signals on a light panel exact location of any spindle not tapping to full depth, and stops the entire line. In addition, patented US Safety Tap Spindles prevent all tap breakage due to dull taps or improperly drilled holes. Installed on transfer machines, this exclusive US development provides dual automatic protection during tapping without need for an extra probing station.

We manufacture all types of adjustable, fixed center and individual lead screw tapping heads. Ask us to help solve your multiple drilling and tapping problems.

US DRILL HEAD

UNITED STATES DRILL HEAD CO.

BURNS STREET • CINCINNATI 4, OHIO

termine the accuracy, repeatability and dependability of the complete system. These tests were comprehensive and took a full week to complete. Inspection reports on the tests brought out some significant facts. First, they showed that while the accuracy obtained on the machined parts was very good, it was not quite up to the 0.002 and 0.004-inch tolerances that we had expected. Even so, we were getting 0.010-inch tolerance, and this was being achieved by workers who were operating a new system for the first time.

The inspection report also revealed that the feed rate was too fast in relation to the cutter diameter, which caused deflection of the cutter. To verify this, positioning tests were run in which the free-running spindle was programmed to cross the 4 by 10-foot work surface diagonally and return to the starting point.

In all of ten such tests it was found that the spindle returned to its starting point within a range of 0.001 inch. This showed conclusively that the control unit had a high degree of repeatability and that the runout was caused by deflection of the cutter. Therefore, we now know that with a cutter and holding fixture of sufficient rigidity, it would be reasonable to expect that we could improve the runout and possibly obtain the 0.002 to 0.004-inch tolerance originally expected.

The slightest lack of rigidity in the tools can greatly reduce the degree of accuracy that may normally be expected from tape control. The day of having a machine operator grind tapers on cutters, add clamps to the fixture, or make trial cuts to compensate or correct for discrepancies, is a thing of the past. None of these things is practical with numerical control. Once the tape is punched and the cut is made, it must be right.

From observations made during three months or so of operation, we expect the machine to run maintenance free 85 to 90 per cent of its planned operating time. Perhaps the indicated 10 to 15 per cent of downtime sounds high, but we are handling a piece of equipment that is far more complex than anything we have had in a machine shop before. Some reduction in this downtime is expected when operating personnel gain a better knowledge of the system and can more quickly detect and correct routine troubles. In addition to the downtime encountered while in operation, we spend from 30 to 60 minutes each day, just prior to going into operation, for preventive maintenance.

The preventive maintenance program as now established consists of running test tapes which bring into operation all phases of the machine control unit. Marginal checks are also run to determine if any electronic components have failed or are weak and about to fail. These tests not only lessen downtime for repair but also will possibly prevent a ruined part due to later failure of a component in the control unit.

Another periodic check that must be performed is the alignment of the milling machine. This alignment check is essential, since any misalignment will be reflected in the machined part. Here again we have a condition that cannot be compensated for by

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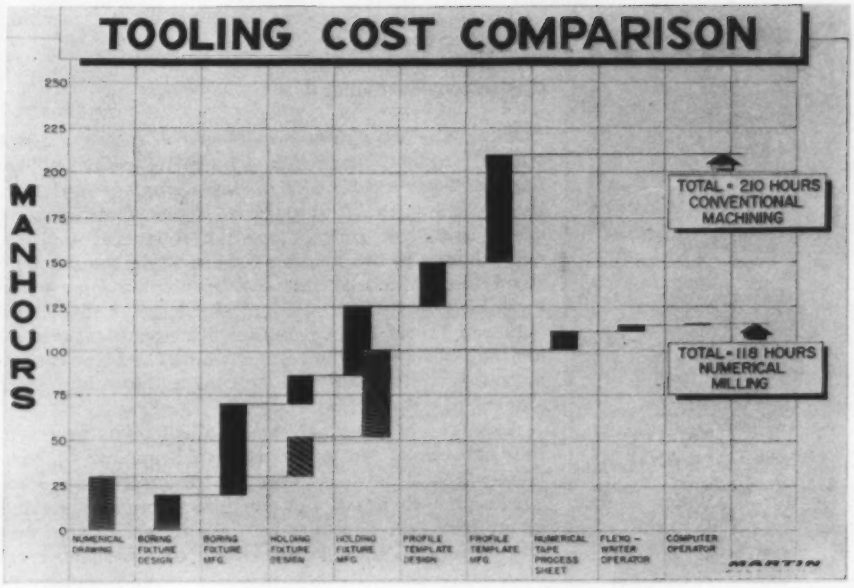
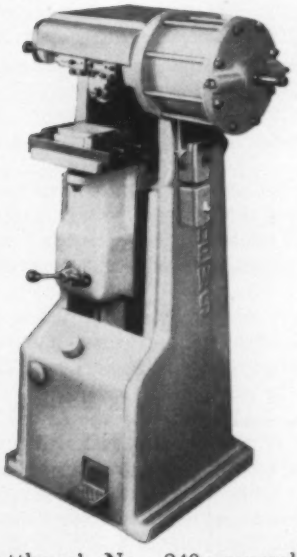


Fig. 3—Tooling time for a typical aircraft part is almost halved by use of numerically controlled milling set-up.

the machine operator as is possible on a conventional machine. He can operate the numerical equipment only in accordance with what has been programmed on the tape. Even if this tape is perfect, the machine will produce parts that deviate from the nominal dimensions in direct proportion to the amount of machine misalignment.

A short time after our machine was installed, we ran a part which inspection refused to accept. We spent hours checking the tape before we realized that the machine was out of alignment. We now check the alignment once a month and will continue



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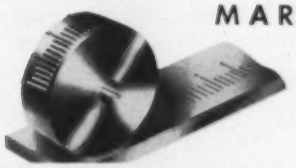

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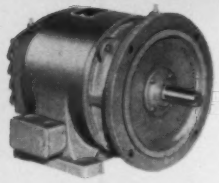
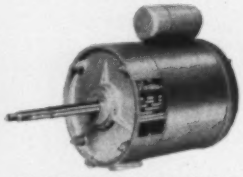


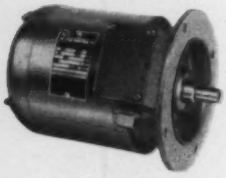
NEMA "D" FLANGE

SPACE-SAVER TYPE MOTOR

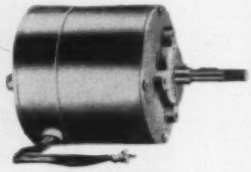
EXPLOSION-PROOF TORQUE MOTOR WITH BRAKE



SPECIAL FLANGE REVERSING HOIST MOTOR SINGLE PHASE



WEATHER-TIGHT SPECIAL FLANGE



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to do so until the natural settling of the machine foundation ceases.

Production Machining

After the acceptance tests were completed, we started production machining on a limited basis. The first part was a rather large aircraft bulkhead fitting. In machining the first part we found that we were spending 50 per cent of our time changing and adding clamps to the holding fixture while the machine stood idle. Much of this lost machining time could have been avoided if we had considered the heavier cuts and faster feeds possible with numerical control and had positioned the clamps where they would have provided the greatest amount of rigidity and least amount of cutter interference.

As might be expected, we also had many errors in the first tape. In order to avoid making a completely new tape each time we discovered an error we decided to break the job into operations having about four feet of leader between them. In this way when we came upon an operation that was incorrect we simply cut out that operation and inserted the corrected one. However, by doing this, it meant that at the end of each operation the spindle would return to a reference point.

There was, of course, a definite reaction against this procedure because, as the spindle returned to the reference point, it was cutting air, not material. However, until we are thoroughly experienced in the making of tapes, we intend to continue to break the job into operations. The few seconds it takes for the spindle to return to the reference point and then go on to the next operation is far less than the time that would be consumed in going back to the beginning and repeating the entire machining operation.

During the initial machining tests, it was noted that the machine worked with an abundance of reserve power and that it was obviously not doing all that it could. Consequently, as we replaced the bad parts in the tape we increased the speeds and feeds on the corrected tape for roughing cuts where a heavier cutter could be used and accuracy was secondary. By the time we had made the last correction we were using speeds and feeds 100 per cent greater than originally planned.

In spite of all the mistakes on this first tape the results were highly gratifying, for we had reduced the rough machining time to 25 per cent of that formerly required by conventional methods. In addition, we had gained a wealth of experience.

These are a few of the growing pains that are inherent in any new concept. While none of us likes to make mistakes, ours have not been entirely in vain, for with each one we have learned more about the limitations and the potentialities of this new system. Some additional gains include lead time and tooling cost savings, *Fig.* 2 and 3.

But the job has only begun. The indoctrination of all people concerned with this new system must be broadened and made more comprehensive. We feel the potentialities of numerical control can be realized only if we train people to think in terms of numerical control. Their thinking must be bold and imaginative

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so that all of the possibilities of this new system can be realized. Certainly their thinking must be as modern and efficient as the machine they work with. This can come about only if they are thoroughly trained.

From a paper entitled, "The Introduction of Numerical Control at Martin" presented at the Third Annual Contour Machining Conference, Los Angeles, Oct. 1957.

AUTOMATION AND PLANT SIZE

By B. J. DRUMMOND
Plant Engineering Dept.
Chrysler Corp.
Detroit, Mich.

IT HAS BEEN OBSERVED that the advent of the automated plant promises for the future a reduction in the sizes of plant facilities. Hypotheses on which this observation is based deserve some consideration. For example, it might reasonably be assumed that:

1. Areas required for the storing of raw materials will be smaller because of the more efficient scheduling capabilities of the automated plant.
2. Finished-stock inventories can be reduced through closer production control.
3. Integrated, multistation, and special purpose production facilities require less floor space.
4. A lower percentage of manning is required to produce a given volume on automated machines.

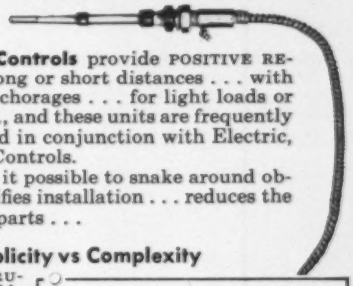
Several factors, however, combine to invalidate the assumption of reduced plant size due to automating. For example, while storage space per unit of volume is reduced for raw and finished stock, organizations that adopt automation usually must have planned for increased *total* production to justify the installation economically in the first place. This, of course, calls for a compensating increase in raw material and finished-stock storage space.

In addition, automated production facilities usually require some provision for storage banks of in-process material which can be drawn on during breakdown and maintenance periods. A further consideration affecting space requirements for automated production facilities is that it sometimes becomes desirable to install twin lines. This allows not only time for maintenance and repair, but can provide greater flexibility in production control of output.

Finally, evidence based on the establishment of an automated facility at our new Mound Road Engine Plant disputes the idea of a decrease in personnel due to introduction of automation. In January, 1954, before the automating of the engine operation, 4,297 workers were employed to build engines. In January, 1955, after the automated plant was in operation, the number of employees had increased to 5,322, and by January, 1956, the number of employees was 6,533. If the picture as presented is typical, we can anticipate an *increase* in the sizes of plant facilities with automation.

From a paper entitled "Impact of Automation on Plant Engineering and Maintenance," presented at the Ninth Plant Maintenance and Engineering Conference, Chicago, Jan. 1958.

Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls

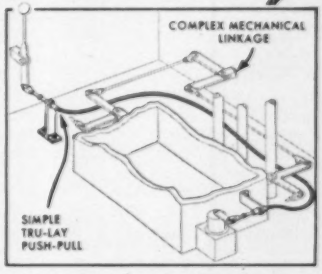


Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

Flexibility makes it possible to snake around obstructions . . . simplifies installation . . . reduces the number of working parts . . .

Simplicity vs Complexity

Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

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Temperatures as low as —70°F will not hinder the proper operation of this unit, and it is thoroughly effective even in the extreme high temperatures encountered on Jet Engine, Furnace Door and Glass Furnace Damper control applications.

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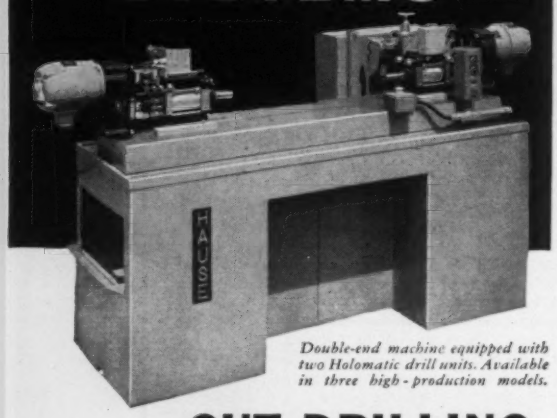
Holomatic SYSTEMS



Double-end machine equipped with two Holomatic drill units. Available in three high-production models.

CUT DRILLING-TAPPING TIME

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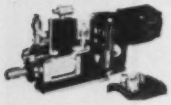
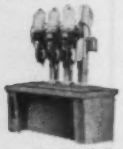
Model 24 — Holomatic Unit For Drilling and Tapping



Model 24—Holomatic for Deep Hole Drilling



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SEMICONDUCTORS FOR AUTOMATION

By H. BRAINARD FANCHER
Gen. Mgr., Semiconductor Products Dept.
General Electric Co.

A TRANSISTOR is usually described as a "pea sized device" that does the same job as the much larger vacuum tube. And that just about describes it to most people. It does do the same job as a vacuum tube; namely, to amplify a small amount of electrical energy into a larger amount of energy. However, the principle by which it operates, the movement of electrons and holes in a solid, is considerably different. This difference from electron tubes gives rise to its outstanding advantages.

The greatest impetus to the rapid development of transistors has been the increasing military dependence on electronics to meet the growing complexity of modern warfare. Every designer of military equipment had been looking for a smaller size active electronic component with increased reliability, improved performance, less heat dissipation, less power drain, less weight, and longer life. Because of the simplicity of a transistor, all of these desires can be accomplished to some degree.

There are no filaments in a transistor as in a tube, which results in less connections, and far less power used or heat generated. In fact the transistor may require only one hundredth the power of a tube. This of course further reduces the size of power supplies and thus the over-all size of equipment.

Since the transistor is a smaller device with a few simple parts, it is far more rugged and can better withstand the shock and vibration to which military and industrial equipment is subjected.

Finally, but of extreme importance, is the useful life of a transistor. Regular commercial vacuum tubes have an expected life of 80 per cent survival after 1000 hours of operation. Highly stabilized 5-star tubes have a life expectancy of 95 per cent in 1000 hours. Transistors, however, have been demonstrated to have a life of 98 per cent survival at 10,000 hours.

So far I have emphasized that the transistor is a small, dependable, and rugged device. But what is the basic transistor—and how in general does it operate? I have mentioned that it is an amplifier. Perhaps a more accurate definition would be to call it a control device. The purpose of such a device is to control large amounts of electrical power with very little power expended to do this. In vacuum tubes this is accomplished by boiling electrons off a special filament wire into space and collecting these electrons on another piece of metal called a plate, at the same time regulating the number of electrons that reach the plate by a small interposed wire grid. It is the very process of boiling the electrons from the filament in a vacuum tube that costs money, creates undesired heat in equipment, and causes the tube to wear out.

In the transistor the electron flow is not through space, but controlled in the solid itself, hence eliminating the expensive requirement of getting the electrons into space where they can be controlled easily.

Mainly, semiconductor rectifiers have been used to replace other means for changing ac current to dc current. Along with the transistor they are competing

for a part of the electron tube function. But in addition they are also competing with selenium, copper oxide, and other types of dry rectifiers. Like transistors, semiconductor rectifiers are small, have virtually unlimited life, and achieve very high efficiency ratings in circuits.

A device called a controlled rectifier—or three electrode rectifier—has been developed in the General Electric rectifier engineering laboratories at Clyde, N. Y. Basically, what our engineers have done is to build some prototype samples of a semiconductor device, using silicon, which will perform the same function as the gas thyratron.

Some of you may never have heard of a gas thyratron or what it can do and therefore have little notion of what a semiconductor thyratron or controlled rectifier means. A simple 2-electrode rectifier changes alternating current to direct current. With such a rectifier, you can pass half the alternating current put into the circuit in the form of direct current. But you cannot practically vary the amount of direct current coming out. This is set by the circuit design. There are several expensive mechanical means for varying the amount of work done by this direct current output. Among them are gear systems, step down transformers, rotating amplifiers, and voltage-varying devices. Gas thyratrons can do the job electronically and eliminate complicated and expensive mechanical methods, but thyratrons are too big and too temperature-limited for many applications. Also, they have life limitations as do other electron tubes.

The controlled rectifier or semiconductor thyratron, on the other hand, is small—about one hundredth the size of equivalent gas thyratrons. Like other semiconductors, it has virtually unlimited life. Where thyratrons are temperature-limited to 90 C, the controlled rectifier will perform at 150 C and possibly even higher.

Probably the biggest use of these new controlled rectifiers will be in military equipment and industrial machinery. They will find wide use in replacing "latching-type" relays in circuits for switching power. They will turn *on* and *off* in 1½ millionth of a second and can be used to vary the amount of power needed to control the speed of motors or to control other functions.

Automation Uses

Much of industry's interest in solid-state science is related to the importance of solid-state devices—like semiconductors—to automation. A key function of electronics in automation is control, and the key requirement for control elements is reliability. Semiconductor devices give every promise of providing the ultimate in long life, reliability and low maintenance that will be required if automation is to be a dependable servant instead of a sick relative requiring constant nursing and medication.

As explained, the key function of electronics in mechanization and automation is control. Included in control, whether of a chemical process, a manufacturing operation, inventory, or distribution, are three functions: 1. Sensing the actual state of affairs. 2. Processing the information so obtained with aids such as computers and instructions stored in memory devices.

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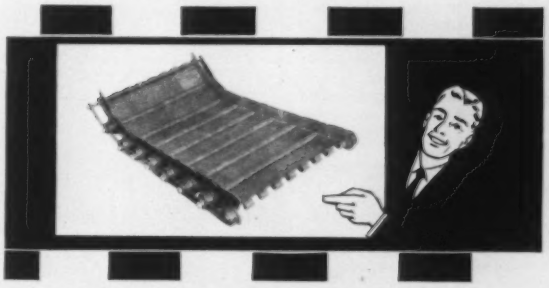
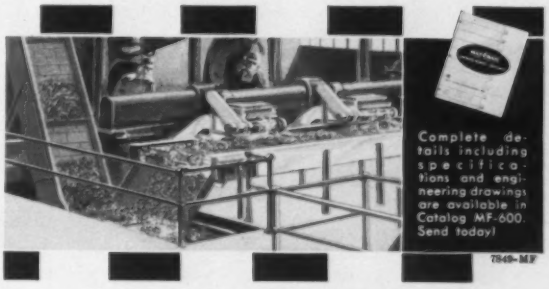


length or contour to meet individual specifications. Links are joined by means of steel rods . . . links, wings and side chain become integral unit.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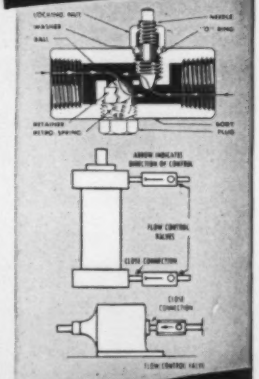
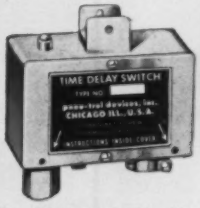
Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check valves and needle valves, incorporating single function features of Flow Control Valve are also available. All valves made in 5 female pipe sizes: ⅛" to ¾". Valve bodies made from brass, aluminum, steel or stainless steel.



TIME DELAY CONTROL SWITCH FOR PRECISE DELAY OF WORK CYCLE



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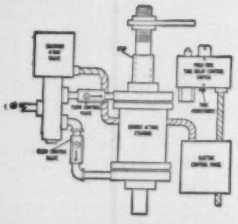
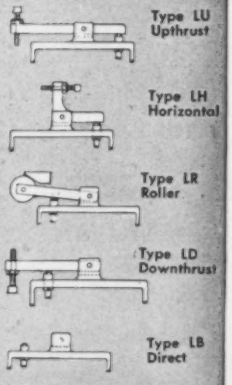


For Any Type Actuation Left or Right Hand (Left Hand Shown)



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Circle 723 on Page 163

3. Execution of the control. For all of these control tasks, semiconductor devices are being developed at an ever increasing pace.

From a talk entitled "More Than Hardware," presented at a meeting of the Cleveland Society of Security Analysts, Cleveland, Nov. 1957.

AUTOMATION AND THE COMMUNITY

By R. H. SULLIVAN
Vice President & Group Executive
Ford Motor Co.

OUR Lima engine plant will be substantially automated—it will carry on possibly the most complicated job yet entrusted to automation. The building of such a plant always seems to arouse curiosity about automation and the effect of automated industry upon the local community. I'd like to give you some very brief comments on that subject from our own experience.

Many of you may have seen pre-war automobile plants. They were marvelous all right, in the same way that a Rube Goldberg contraption is marvelous. You admired their complexity—and perhaps wondered what held them together.

Over the years, we had achieved considerable skill in throwing together a jungle of assorted tools and conveyors. Plant layout had grown into a specialized art requiring the combined skills of the engineer, the accountant and the three-dimensional chess player.

As each individual process was improved, we made a piecemeal adjustment in the over-all production process, and as the automobile itself became more and more complicated, we frantically modified our techniques—and added to the confusion.

I don't mean that our factories had no automatic machines. In one sense we were too automatic—we had too many unrelated machines. We found, for example, that it was fast becoming impossible to utilize the full capacity of up-to-date machine tools, because men couldn't load and unload them fast enough by hand.

Integrated Facilities

In place of the old, complicated maze of machinery, we visualized long, clean production lines along which our parts and materials would flow evenly and smoothly—just as fast as modern machine tools could handle them. The processes of automatic lubrication, scrap removal and, to some extent, quality testing would be integrated into the lines. The new lines would be equipped with various control devices to assure effective preventive maintenance.

Over a period of years, we have made that dream come true. We have introduced automation into many of our operations which are adaptable to it. Automation, we find, has had important broad effects upon the whole manufacturing process.

First, it has enabled us to provide safer and healthier working conditions for our employes.

Second, we're getting better quality. There's less damage caused by parts bumping into each other

or falling to the floor. In some cases, we've been able to build quality control gages right into production lines and have tied them into our equipment.

Third, automation has resulted in lower production costs.

And finally, we have been able to utilize our machines more fully and effectively. In some machines, the rate of production is determined by the length of time taken by loading and unloading operations. Automatic transfer devices make it possible to operate these machines nearer to their maximum rated capacity.

The great problem of an automated plant is to coordinate a number of vastly complicated operations into a harmonious whole. The entire operation must be geared to the slowest single operation. One of the beauties of automation is that it highlights your bottlenecks and creates an enormous pressure for their solution. For automation engineers, life is just one bottleneck after another.

Community Benefits

So far as the impact of such plants on the community is concerned, they are in general attractive, clean, and quiet. They are designed from the standpoint of eliminating possible points of nuisance to the surrounding community, as well as from the industrial efficiency viewpoint.

One particularly interesting question is how they affect the local labor market. Remarkably enough, we have been told by other manufacturers that while our arrival was initially viewed with some concern by other manufacturers, they found in a relatively short while that there was a considerable increase in the availability of high class skilled labor. There is a good reason for that.

First of all, we believe that the excellent working conditions in these new plants attract high-class people into the local labor market. Second, each of these plants becomes a training center for skilled workers and potential industrial foremen and supervisors. We carry on a pretty elaborate program of classes and training in numerous areas ranging from electrical maintenance to cost accounting and industrial engineering.

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As a result, we look to the community where we can find ambitious, stable, intelligent workers, and we tend to bring into the community the kind of people who will be a credit to that community.

From an address before a meeting of the Lima Association of Commerce, Lima, Ohio.

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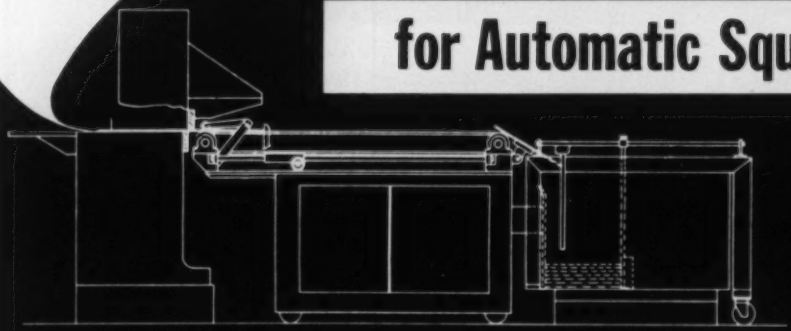
for Automatic Square Shearing



After setting the precision measuring device and adjusting the attached stacker, the operator merely starts the sheet thru the shear, engaging the pinch rolls and the Shear-Matic does the rest. It swiftly feeds the sheet into the stops, automatically cycles the shear, transfers the cut sheet into the stacker and stacks it neatly.

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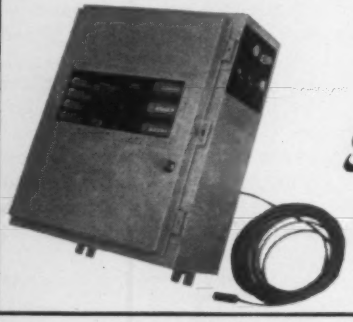

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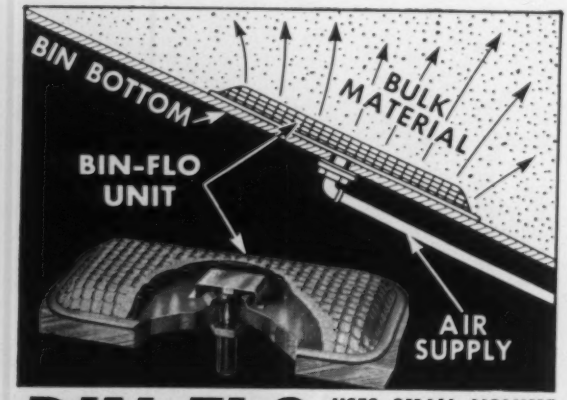
Circle 725 on Page 163



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USES SMALL VOLUME OF AIR AT LOW PRESSURE

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BIN-FLO units in bins, chutes, hoppers, etc., restore flow characteristics to dry, finely ground materials which tend to pack or bridge in storage. Types for all materials and conditions. No moving parts; simple installation; negligible operating cost; no maintenance cost.

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Circle 726 on Page 163

AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D.C.

POWDER FEEDING METHOD AND APPARATUS

Electric current and finely divided solid material having paramagnetic properties are conveyed to an electrical conductor without the occurrence of magnetic damming of the powder. Patent 2,805,323 by Everett H. Cushman, assigned to Air Reduction Co. Inc.

MACHINES FOR SEALING SHIPPING CARTONS OR THE LIKE

Cartons of different heights are conveyed under an endless pressure belt consisting of closely spaced, flexibly connected, traverse rollers. The driven pressure belt contains sufficient slack to sag substantially below the tops of the lowest cartons. Patent 2,805,533 by Kaye B. Holstebroe, assigned to Emhart Mfg. Co.

CARD FEED STATION

Automatic system continuously moves flexible punched cards from a card stack at a rate in excess of 1000 cards per minute and transports them in a spaced sequential relationship. Rotating drum picks up cards from the stack by means of friction aided by a partial vacuum. Patent 2,806,695 by Kenneth Robert Carlisle, assigned to Hughes Aircraft Co.

RECORDING APPARATUS

Parallel conductors secured longitudinally to an elongated strip of nonconductive material are selectively heated in small portions by a recording means. Physical changes to the conductor in the heated area represent recorded bits of information. Patent 2,806,756 by Jacob V. Van Der Werff, assigned to Consolidated Electrodynamics Corp.

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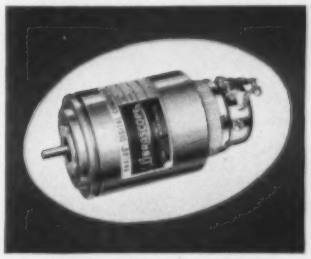
Circle 727 on Page 163

Analog-Digital CONVERTERS

Packaged units for conversion of Shaft Position-to-Digital Code for Computers and Data Handling Systems

Types: Librascope offers these converters with outputs in Binary, Binary Coded Decimal and Grey code.

Capacities: In Binary, four models with capacities of 7, 13, 17 and 19 bits available, i.e., Model 707, 713, 717, and 719. In Binary Coded Decimal; four models with capacities of 2000, 20,000, 3600 and 36,000 counts are available, i.e.,Models 723, 724, 733, and 734. In Grey code one model with a capacity of 8 bits is offered, i.e., Model 708.



Features: Reliability, accuracy, small size ruggedness, long life and high speed capabilities are the features which have established Librascope converters as leaders in the field. Utilizing a staggered, double brush pick-off which provides the means for unambiguous readout they can be read serially or in parallel with equal facility. Time sharing of many converters with a single computing element is accomplished with isolation diodes which are mounted internally on special order.

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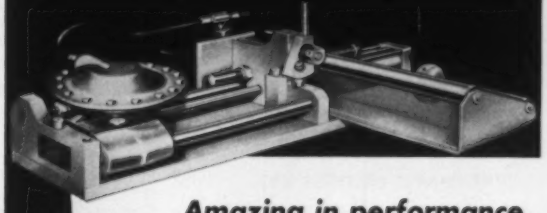
Construction: All units are Synchro mounted. Materials of the highest quality non-corrosive and non-fungus nutrient properties are used throughout. The units are small in size compared to their capacities.

For additional information write for catalog E10-1. Address Librascope, Inc., subsidiary of General Precision Equipment Corp., 816 Western Avenue, Glendale, California.

Circle 729 on Page 163

Ses-Matic AIR FEED

for feeding coiled stock to presses



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Circle 730 on Page 163

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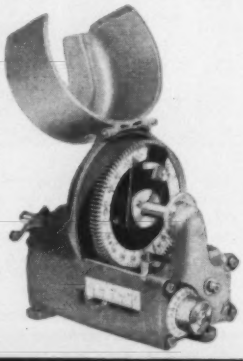

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Circle 732 on Page 163

testing at a subsequent series of stations. Patent 2,807,350 by Charles C. Rayburn and James G. Black Jr. assigned to United States of America.

LIQUID REMOVAL APPARATUS

Continuous web of film moves through a loop formed by a thin metal band supported by rotating pulleys. Excess liquid is removed from both sides of web by contact with the upper and lower passes of the metal band. Patent 2,807,891 by Howard Earl Roscoe, assigned to E. I. du Pont de Nemours and Co.

AUTOMATIC LIQUID SAMPLER

Driven rotatable external sleeve surrounding a conduit periodically brings an opening in the sleeve into radial alignment with an opening in the conduit so that a representative sample of liquid may be withdrawn from the conduit. Patent 2,807,961 by William W. Grimes, assigned to Standard Oil Co.

THUMB TACK SORTING APPARATUS

Barrel rotating about a horizontal axis has perforations in its peripheral walls adapted to receive perfectly-formed shanks of thumb tacks loaded into the barrel. Perfect units enter perforations and, as the barrel rotates, drop into means within the barrel for catching the tacks. Patent 2,808,930 by James J. Reilly, assigned to Waterbury Tack Co. Inc.

SHEET-SEPARATING APPARATUS

Sheets are removed one at a time from the bottom of a stack by means of a tab adhered to one edge of each sheet. Patent 2,809,032 by Niels Krag, assigned to International Telemeter Corp.

PNEUMATIC DELIVERY BOX

Circular perforated disk rotates between the adjacent ends of two aligned lengths of ducting. Material carried pneumatically in duct collects on face of disk which rotates, displaces a sealing means, and deposits material outside of ducting. Patent 2,810,-937 by Arthur Linnert and Gordon Short, Manchester, England.

MAGNETOSTRICTIVE TYPE PRINTING DEVICE

Tape moves through a chamber containing a cloud impregnated with ink particles in suspension and a pulse element with a printing character configuration on one end. Magnetostrictive pulsing action of a coil on the pulse element causes ink particles to solidify between character configuration and tape, printing same. Patent 2,811,101 by George C. Devol, assigned to Sperry Rand Corp.

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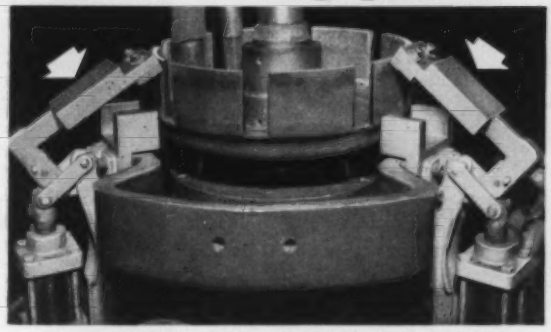

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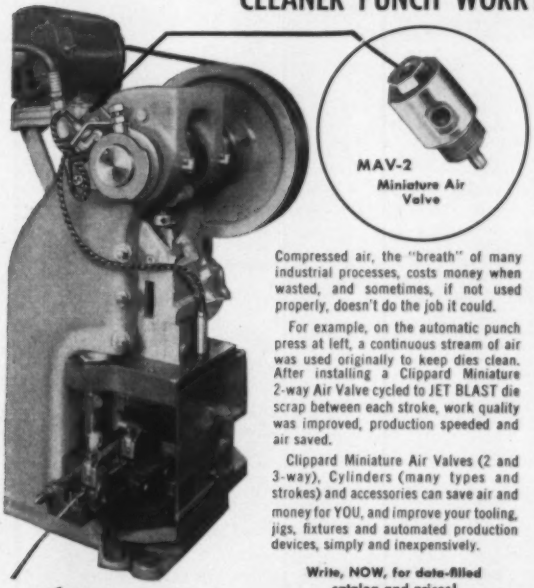

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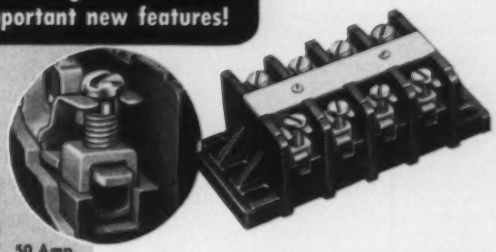

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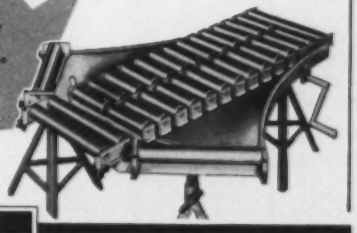

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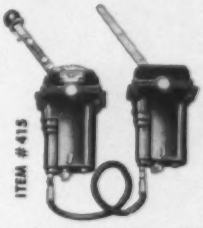

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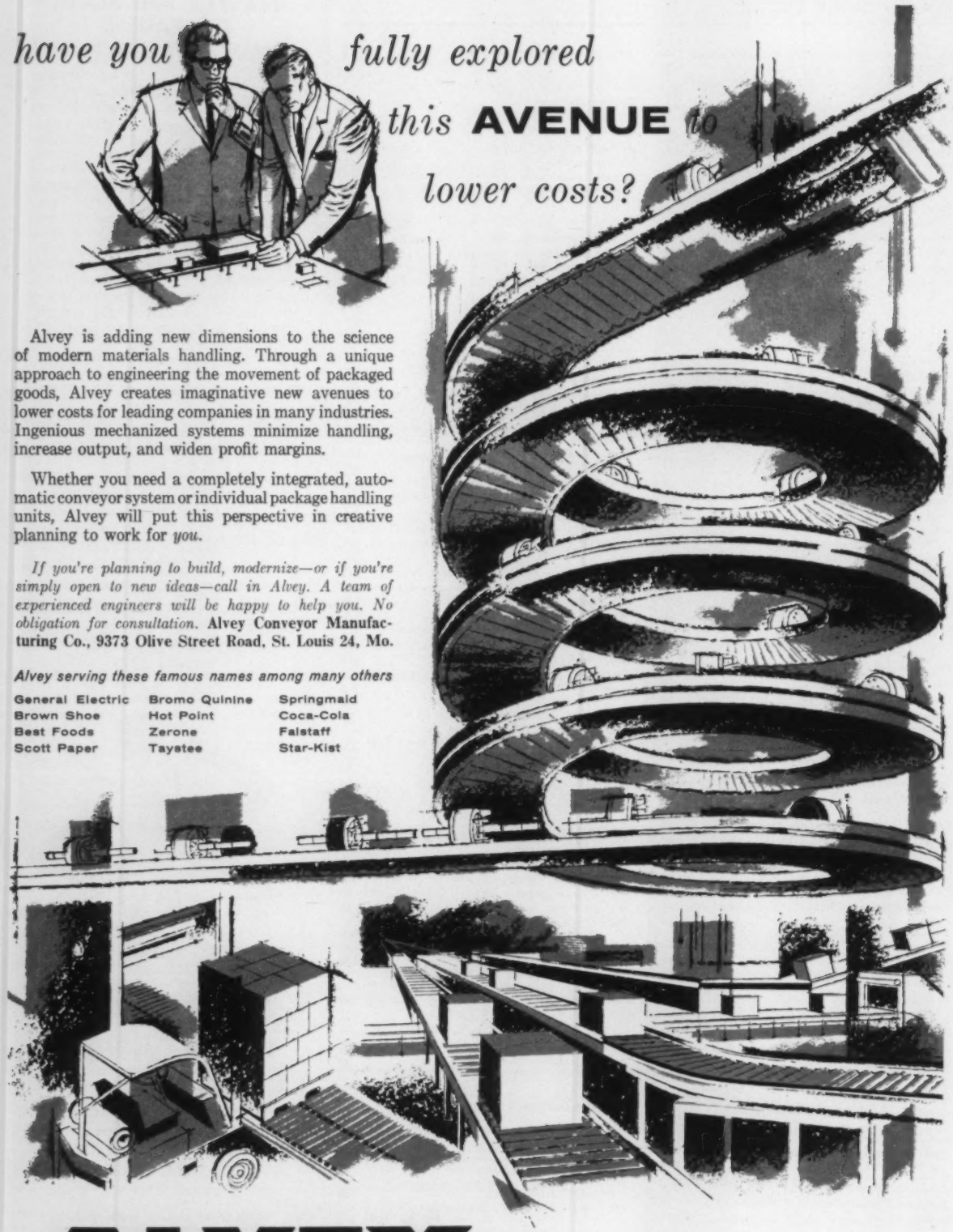

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Electrical Controls

Zenith Electric Co., Dept. ANC, 152 W. Walton St., Chicago 10, Ill.—64 page catalog—Electrical control equipment such as automatic transfer switches, magnetic contactors, remote control switches, program clocks, automatic reset timers, and cycle timers are described in Catalog 18. Applications, construction details, operating features, design specifications, technical data, and prices are covered.

Circle 490 on Page 163

Cable Supporting Systems

T. J. Cope Div., Rome Cable Corp., Collegeville, Pa.—60 page catalog—Catalog 1257 is divided into five sections and covers cable troughs of galvanized steel, cable troughs of aluminum, cable ladders and channels of galvanized steel, cable ladders and channels of aluminum, and system supports and accessories. Dimensions, specifications, and diagrams are included.

Circle 491 on Page 163

Automatic Welding

National Electric Welding Machines Co., 1846 Trumbull St., Bay City, Mich.—4 page pamphlet—Four models of arc welders for the production of automotive components are noted and illustrated in Welding News, Vol. 11, No. 2. Machines described are the dial feed arc welder, drum feed CO_2 arc welder, five head automatic welder, and six head automatic arc welder.

Circle 492 on Page 163

Distribution Components

Distribution Unit, General Electric Co., Plainville, Conn.—144 page catalog—Condensed information on products of two departments, Distribution Assemblies and Circuit Protective Devices, is contained in Bulletin GEC-1032B. Data on low-voltage distribution equipment and components such as safety switches, circuit breakers, tumbler switches, panelboards, busways, wireways, and motor control centers, are presented.

Circle 493 on Page 163

Abrasive Belt Grinding

Engelberg-Huller Co., 831 W. Fayette St., Syracuse, N. Y.—24 page handbook—Four models for abrasive belt grinding are covered. Machines described are the multiple-head conveyor-type belt grinders, platen-type belt grinder with automatic infeed tables, centerless belt grinders, and special units designed for specific production requirements. Numerous case histories are presented and data on production figures, types of belts used, belt life, tolerance, and finish specifications are given.

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Timing Belt Drives

Morse Chain Co., Ithaca, N. Y.—68 page catalog—Five basic belt pitches from 1/5-inch to 1¼-inch are covered in Catalog TB-58. Drive details, sprockets, and horsepower capacity ratings are listed. Data on selection procedure, applications, and installation are also included.

Circle 495 on Page 163

Corrugated Cartons

International Paper Box Machine Co., 315 Main St., Nashua, N. H.—20 page booklet—Model LB, a corrugated carton gluer, is described. Various components in the machine such as the feed section with center guide control, the non-clog gluepot, the folding section, and the electronic counter for accurate bundling are explained and illustrated. Equipment produces a carton based upon a new concept of creasing and folding.

Circle 496 on Page 163

Rotary Feeder

Beaumont Birch Co., 1505 Race St., Philadelphia 2, Pa.—4 page pamphlet—Data on eight-pocket rotary feeder for feeding bulk chemicals into industrial processes at differential pressures up to 25 psi are given. Operation, design and outside adjustments of the unit are explained, safety features noted, and schematic drawings included.

Circle 497 on Page 163

Speed Control

Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis.—12 page booklet—Select-A-Spede, a control for regulating speed and tension for individual drives, or for precision matched interlocked multimotor drives is described in Bulletin 2000. Dimensions and performance data are noted and instructions for installing the control, which is applicable to machine tools and conveyors in the paper and textile industries, is given. Design features of the power unit, drive motor, and push-button station are explained.

Circle 498 on Page 163

Photoelectric Controls

Autotron Inc., Box 722 RR, Danville, Ill.—24 page handbook—Data on photoelectric and electronic controls for automatic weighing, sorting cartons, counting small objects, counting bottles, and bin level control, are given in Catalog 58. A complete series of light sources; normal, small, and miniature phototube and light source heads; electronic timers, and controls operated by current surge and impact are described.

Circle 499 on Page 163

Gear Line

Gear Div., Charles Bond Co., 617-23 Arch St., Philadelphia 6, Pa.—80 page catalog—Data on stock gears, speed reducers, sprockets and chains, flexible couplings, universal joints, collars, and pillow blocks are given in Catalog 100. Dimensions, specifications and charts for the selection of speed reducers and stock gears are included. One section is devoted to general engineering tables.

Circle 500 on Page 163

Pulley Lagging

Condersite Engineering Corp., 2015 Chancellor St., Philadelphia 3, Pa.—4 page pamphlet—Data on pulley lagging which is suitable for conveyors, industrial heating equipment, paper, grain, and food processing machinery are given. Composition of the material, which eliminates belt slippage and aids automatic operations where belt motion is co-ordinated with other phases of a process, is explained. Illustrations and instructions on applying the lagging are included.

Circle 501 on Page 162

Milling Spindles

Romulus Tool & Engineering Co., 13581 Huron River Dr., Romulus, Mich.—12 page booklet—Line of hydraulically driven milling spindles in models to 50 hp is covered in Catalog RT-58. Specifications, construction features, and operating characteristics are listed, and illustrative examples of applications given.

Circle 502 on Page 163

Fluid Flow Valves

Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.— 56 page catalog—Line of valves rated for oil, water, and air pressures from zero to various pressures up to 10,000 psi in four way, three way, shut off and diverter flow patterns, manual and solenoid is covered in Catalog 58-59. Graphs showing the means of calculating pressure drop, discharge and velocity of liquids are included. One section gives data on the maintenance of valves and lists the remedies to numerous problems.

Circle 503 on Page 163

new catalogs..... latest literature

Tape Control for Machine Tools

Controls Section, Bendix Aviation Corp., 21820 Wyoming Ave., Oak Park, Mich.—12 page booklet—Tape control system for controlling the production of machined parts is discussed in Bulletin BR-1. Diagrams and illustrations show the system from the numerical drawing stage to the control tape and the machine tool control unit. Typical machine tool systems are explained, and specifications noted.

Circle 504 on Page 163

Chain Oilers

Trico Fuse Mfg. Co., 2948 N. Fifth St., Milwaukee 12, Wis.—4 page pamphlet—Device which applies a film of oil to chains, gears, slides, or irregular surfaces is described in Bulletin 39. Single line and multiple line systems are mentioned and specifications given for them. The difference in the various available models of applicators is also explained.

Circle 505 on Page 163

Soot Blower Controls

Copes-Vulcan Div., Blaw-Knox Co., Erie 4, Pa.—16 page booklet—Line of automatic soot blowing control systems for boilers is covered in Bulletin 1029. Dimensions, specifications, and descriptions of the selective sequence and automatic-sequential insert-type panel controllers are given. Installation illustrations show the variety of applications for which the equipment is suitable.

Circle 506 on Page 163

Magnetic Drives

Whitney Chain Co., Hartford, Conn.—8 page bulletin—Magnetic drive, which consists of a magnetic rotor and a bimetallic rotor, is discussed. Drive features such as dynamic braking and motor protection are described, and the drive theory explained. Illustrations of magnetic drive applications are also given.

Circle 507 on Page 163

Materials Handling Equipment

Materials Handling Div., Heppenstall Co., 5th Ave. & 16th St., New Brighton, Pa.—20 page booklet—Numerous types of lifting equipment ranging in size from small automatic tongs to sheet lifters are covered. Described and illustrated are automatic tongs, motorized tongs, rotating and forged crane hooks, tilters and upenders, and sheet lifters.

Circle 508 on Page 163

Antifriction Bearings

Industrial Tectonics Inc., 3686 Jackson Rd., Ann Arbor, Mich.—24 page handbook—Data on antifriction bearings of unusual shapes and sizes are contained in Bulletin AFB-2. Information on high-temperature component materials, corrosion resistance, nonmagnetic properties, and specialized operating conditions is given. Bearing sizes are discussed and drawings showing typical bearing designs are included.

Circle 509 on Page 163

Electro-Probe Gaging

Federal Products Corp., 1144 Eddy St., Providence 1, R. I.—4 page pamphlet—Instrument which consists of a portable dimensional indicator, and an electronic table positioning device is described. Specifications are listed and operating characteristics explained. Illustrative examples of the gage in use are included. Available accessories are also mentioned.

Circle 510 on Page 163

Power Supplies

NJE Corp., 345 Carnegie Ave., Kenilworth, N. J.—16 page booklet—Numerous power supplies such as brute force, thyratron regulated, transistorized solid state, vacuum-tube regulated, high voltage, and transistor-driven magnetic amplifier models are discussed. Prices, formulas, tables, diagrams, and application data are included.

Circle 511 on Page 163

Metalworking Presses

Lake Erie Machinery Corp., Box 68, Kenmore Station, Buffalo 17, N. Y.—12 page booklet—Four-column metalworking presses for deep metal drawing are described in Bulletin 7.13. Applications and advantages of the double and triple action hydraulic presses are noted, and the design and operation of the double platen explained. Numerous illustrations of the different size presses, ranging from 75 to 4000 tons, are included.

Circle 512 on Page 163

Pneumatic Controllers

Fischer & Porter Co., 489 Jacksonville Rd., Hatboro, Pa.—12 page booklet—Motion-balance pneumatic controllers with a regenerative feedback circuit are discussed in Catalog 53P-4000. Operating principle is explained and a chart for selecting the proper controller is also included. Illustrations of the various types of controllers are given.

Circle 513 on Page 163

Controlled Index Table

Modern Engineering Service Co., 1695 Twelve Mile Rd., Berkley, Mich.—4 page pamphlet—Electronically controlled precision digital index table, which has a repetive accuracy to within 1 second of arc on any diameter is described. Point-to-point positioning is explained and features of the unit are noted.

Circle 514 on Page 163

Industrial Hose

J. N. Fauver Co. Inc., 51 W. Hancock, Detroit 2, Mich.—32 page catalog—Assemblies, couplings, stems, swivels, and accessories are described in Catalog 57. Data on the application, selection, and mounting of hose are given. Also discussed are how to apply hose clamps, and how to remove and install circle clamps, hose stems, and hose assemblies.

Circle 515 on Page 163

Vertical 4-Slide Machine

A. H. Nilson Machine Co., Shelton, Conn.—4 page pamphlet—Vertical 4-slide machine for wire and metal forming is described in Catalog V-187. Design features and advantages are noted and complete specifications given. Standard equipment, equipments options and accessory parts, such as press attachments and stock reels, are listed.

Circle 516 on Page 163

Air Compressors

Quincy Compressor Co., Quincy, Ill.—12 page booklet—Single stage and two stage, horizontal and vertical tank type compressors are covered. Construction advantages and specifications are noted, and features of the components in the compressors illustrated and explained.

Circle 517 on Page 163

Electronic Mill Regulator

Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio—6 page pamphlet—Data on the dual-circuit electronic regulator unit which provides precise regulation of line speed, voltage, and tension for all continuous-process industries are given in Bulletin K-2503. Operating principle and design of the dual-circuit are described. Additional features are also noted.

Circle 518 on Page 163

Thermometers

Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim avenues, Philadelphia 44, Pa.—56 page catalog—Line of indicating, recording, and controlling thermometers is discussed in Catalog C-60-2. Vapor actuated, gas actuated, and mercury actuated thermometers and thermal systems for use between the temperature limits of − 125F to 100F are listed and explained. One section is devoted to specifications, dimensions, and chart selection information.

Circle 519 on Page 163

Worm & Gear Mountings

Cone-Drive Gears, Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.—20 page booklet—Line of standard mountings and details such as bearings, caps, carriers, and seals for double-enveloping worm gearsets are described in

Bulletin 750-C. Charts list all the parts furnished with standard worm and gear assemblies, which can be used for worm over, worm under, or gear shaft vertical installations. Engineering drawings, specifications, and ordering instructions are included.

Circle 520 on Page 163

Electrical Connectors

Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.—62 page catalog—Line of plugs and receptacles designed for severe industrial environmental conditions is described in Bulletin 1252-1. Types of connectors covered are cable connectors, panelboards, bulkheads, and conduit fittings. Data on performance requirements, dimensions, assembly instructions, and installation procedure are given.

Circle 521 on Page 163

Double Geared Presses

Minster Machine Co., Minster, Ohio—8 page bulletin—Two point, straight side, double geared presses designated series MS2 and ranging in capacity from 150 to 500 tons are covered in bulletin. The combination air friction clutch and brake drive arrangement, which provides more single stroke operations per minute, is explained. Dimensions, specifications, standard features, and extra equipment are listed.

Circle 522 on Page 163

Hydraulic Cylinders

Oilgear Co., 1571A W. Pierce St., Milwaukee 4, Wis.—8 page bulletin—Line of double-acting hydraulic cylinders rated to 2000 psi is covered in Bulletin 71000. Foot lug, center lug, front flange, rear flange, and clevis mounting cylinders are described. The self-aligning adjustable hydraulic cushions used in the cylinders are also explained.

Circle 523 on Page 163

Discs & Disc Grinders

Gardner Machine Co., Dept. 21, Beloit, Wis.—24 page catalog—Flat surface disc grinders, abrasive discs, and cylinder wheels are discussed in Bulletin CG-58. Illustrations display the basic types of disc grinders, work carrying fixtures, variety of shapes and sizes of workpieces ground, automation in disc grinding, and the range of sizes and types of faces of abrasive discs.

Circle 524 on Page 163

Venturi Meter Tubes

Builders-Providence Inc., 345 Harris Ave., Providence 1, R. I.—32 page handbook—Data on various types of venturi tubes are contained in Bulletin 110-P1. These data include recovery characteristics, formulas to determine the design, and typical calculations. Specifications, installation instructions, and accessories available are mentioned.

Circle 525 on Page 163

INDEX OF PRODUCTS BY ITEM NUMBERS

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Compacting Press

Hamilton Div., Baldwin-Lima-Hamilton Corp., Hamilton, Ohio—4 *page pamphlet*—Features and performance of 50-ton compacting press for powdered metals, plastics, carbides, cermets, and ferrites are noted in Bulletin 3107. Components of the press, such as hydraulic head control to prevent overloading, floating die holder for positive movement control, and separate controls for depth of fill adjustment and bottom punch stroke, are described.

Circle 526 on Page 163

Instrument & Control Switches

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.—8 *page bulletin*—Switches which can be used in conjunction with circuit breakers, transformer tap changers, motor-operated rheostats, and other types of electrically controlled units are decribed in Bulletin 14B8112A. Data on operation, construction, and various components are given. Dimensions on removable handles are also included.

Circle 527 on Page 163

Dripproof Motors

Small AC Motor & Generator Dept., General Electric Co., Schenectady 5, N. Y.—16 *page booklet*—Standard line of dripproof and totally enclosed motors in ratings up to 125 hp is covered in Bulletin GEA-6602. Cutaway picture displays features of the motor. Other illustrations show advantages of performance, installation, and maintenance. Charts showing how to modernize present equipment are included.

Circle 528 on Page 163

Automatic Packaging Machines

Lynch Robo Corp., Div., Lynch Corp., Anderson, Ind.—4 *page pamphlet*—Pillow-type packaging machines which handle solids, powders, liquids, or granules are described. Packaging action is explained and equipment which can be integrated into a production line is discussed.

Circle 529 on Page 163

Vibration Control Mountings

Korfund Co. Inc., 48-8 32nd Place, Long Island City 1, N. Y.—4 *page pamphlet*—Data on fifteen different types of machinery mountings, using steel springs, rubber, and cork, are given in Bulletin K4D. Engineering specifications and performance data are listed and a selection chart, telling under which conditions the various media perform best, is included.

Circle 530 on Page 163

Automatic Interpolation

Polytechnic Research & Development Co. Inc., 202 Tillary St., Brooklyn 1, N. Y.—6 *page pamphlet*—Automatic interpolation with spiral-scale dials, which permits interpolated measurements to be read without computation, is explained. Operation of the dial, scale expansion and compression are discussed. The use of the dial scale on a frequency meter is described.

Circle 531 on Page 163

Gamma Radiation

Applied Radiation Corp., 2404 N. Main, Walnut Creek, Calif.—*technical report*—"Production of Gamma Radiation with a Linear Electron Accelerator" is the subject of Report AM-100. Data are applicable in designing commercial irradiation installation, and for surveying the technical and economic feasibility of high energy radiation processing.

Circle 532 on Page 163

Memory & Information System

Dayton Systems, Div., Daystrom Inc., 5640 La Jolla Blvd., La Jolla, Calif.—2 *bulletins*—Bulletin 104 covers transistorized magnetic core memory systems, which are applicable for data handling, process monitoring and control, and buffer storage. Various parts in the system are described and illustrated, and a block diagram of a memory core system is given. Bulletin 103 describes the operational information system, a concept incorporating a digital computer with magnetic core memory. Computational and programming flexibility are explained, and specifications for the digital control computer are mentioned.

Circle 533 on Page 163

Fluid Flow Rate Alarms

Brooks Rotameter Co., Lansdale, Pa.—4 *page pamphlet*—Magnetic and electronic flow alarms, which are suitable for signalling or simple control functions, are covered in Bulletin 165. Features, specifications, and operating principles for both types of alarms are given. Also included are drawings showing the interchangeable metering elements in the basic flow sensing instrument.

Circle 534 on Page 163

Compression Sheath Connectors

Omaton Div., Burndy Corp., Norwalk, Conn.—16 *page booklet*—Line of one-piece and two-piece compression sheath connectors for shielded or coaxial cable is described in Bulletin YEC-7. Both insulated or unisulated connectors, which are color coded, are included. The crimping method is explained, and proper selection procedure given. Also included are illustrations showing the step-by-step procedure in assembling the connectors.

Circle 535 on Page 163

Precision Spindle

Whitnon Mfg. Co., Route 6 & New Britain Avenue, Farmington, Conn.—32 *page handbook*—Various models of precision spindles for all types of boring, milling, grinding, and drilling operations, as well as special applications, are covered. Style numbers, specifications, and schematic drawings are given. Also included are data on attachments for surface grinders.

Circle 536 on Page 163

Blending System

Fuller Co., Catasauqua, Pa.—4 *page pamphlet*—The Airmerge system, a means of blending pulverized materials in a silo through quadrant aeration is described in Bulletin B-1. Development and principles of the system are explained. Data and illustrations of a typical installation are also given.

Circle 537 on Page 163

Precision Grinders

Arter Grinding Machine Co., 89 Sagamore Rd., Worcester 5, Mass.—8 *page bulletin*—*Rotary* surface grinders, cylindrical-internal grinder, and Jigmatic tape-controlled positioning table are described and illustrated. Specifications and features of the machine are noted. Procedure for the preparation of data and tape for numerical controlled machine is also given.

Circle 538 on Page 163

Corrugated Box Packaging

Hinde & Dauch, Sandusky, Ohio—24 *page booklet*—Data on the designing, testing, and sorting of product packages are given in Booklet 5. Tips on selecting the proper box, correct sealing, and storage methods and efficient shipping procedures are included.

Circle 539 on Page 163

Variable Speed Drives

Graham Transmissions Inc., Menomonee Falls, Wis.—12 *page booklet*—Line of variable speed drives, which produce increased torques at either maximum or minimum speed, is described in Bulletin 550. Operating principles, features, and advantages are noted. Data on how to match the drive to the application, and how to select the right drive are given. Also presented are systems for automatic control of speed.

Circle 540 on Page 163

Filtration Equipment

Commercial Filters Corp., Melrose, Mass.—8 *page bulletin*—Line of filtration equipment for micronic clarification of industrial fluids is described and illustrated in Bulletin GEO-506. Construction of the filter tubes is explained and data on filters for diesel and gasoline engine lubricating oils are also included.

Circle 541 on Page 163

Welder Control Circuits

Taylor-Winfield Corp., Warren, Ohio—8 *page bulletin*—Counting tube circuits used in resistance welder controls are described in Bulletin SP-19. Operating principles are explained and schematic diagrams included to illustrate purpose and principles of the controls.

Circle 542 on Page 163

Hydraulic Hose Fittings

Parker Fittings & Hose Div., Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio — 8 *page bulletin*—Fittings suitable for use with rubber covered wire braided hydraulic hose in sizes from 3/16 through 1-1/8 inches ID are described in Catalog 4440. Hose and hose assemblies are listed. Data on how to make up assemblies are also included.

Circle 543 on Page 163

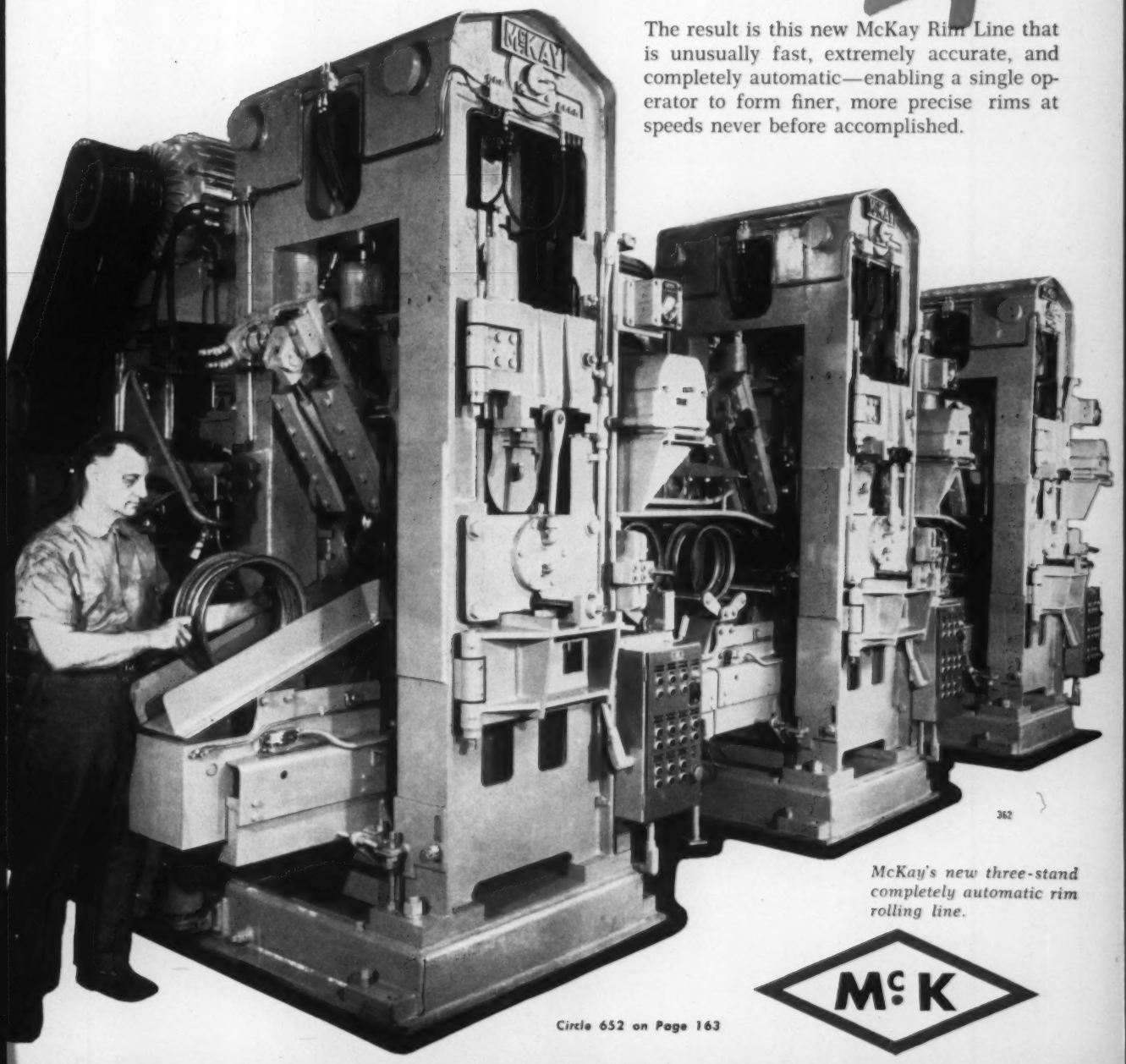
NEW, AUTOMATED McKAY RIM LINE SPEEDS PRODUCTION OF PRECISION WHEELS FOR TUBELESS TIRES

The advent of the tubeless tire, coupled with ever increasing labor costs, pushed wheel manufacturers to request machines that could turn out better rims at faster rates.

Because McKay Machine engineers know this business better than any other group in the nation, they accepted the challenge.

BETTER RIMS ... automatically

The result is this new McKay Rim Line that is unusually fast, extremely accurate, and completely automatic—enabling a single operator to form finer, more precise rims at speeds never before accomplished.



McKay's new three-stand completely automatic rim rolling line.

McK

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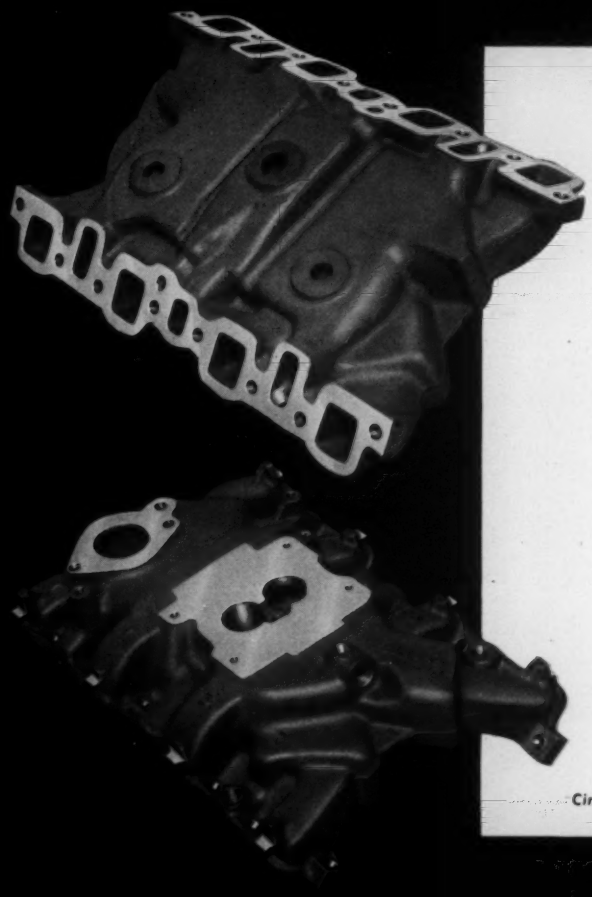

Truck Manifolds Completely Machined, Re-positioned 5 Times, in 55 Seconds

This 25-station LeMaire "Producer" completely machines three different styles of truck engine manifold castings. The machine is built for transfer-through operation and features automatic loading and clamping at each station. The part is re-positioned five times while in process during the 55-second machining cycle, including one 180 degree roll-over, one rotation for vibratory chip removal, indexing for a probing operation, one 90 degree index and re-index.

Features include: Unitized "building block" construction, with provision made for future changes—lighting at every work station—complete electrical interlock and individual selector switches and controls at each work station—"PresTest" lights on main control console—automatic selective lubrication of fixtures and ways—lights indicating "Automatic" or "Manual" control for safety during setups — electrical and hydraulic systems to J.I.C. — 189 hp electrical system—hardened and ground wear surfaces.

Here is another successful *producing* installation, designed, manufactured and tooled by LeMaire. Tell us about *your* next production machining problem.

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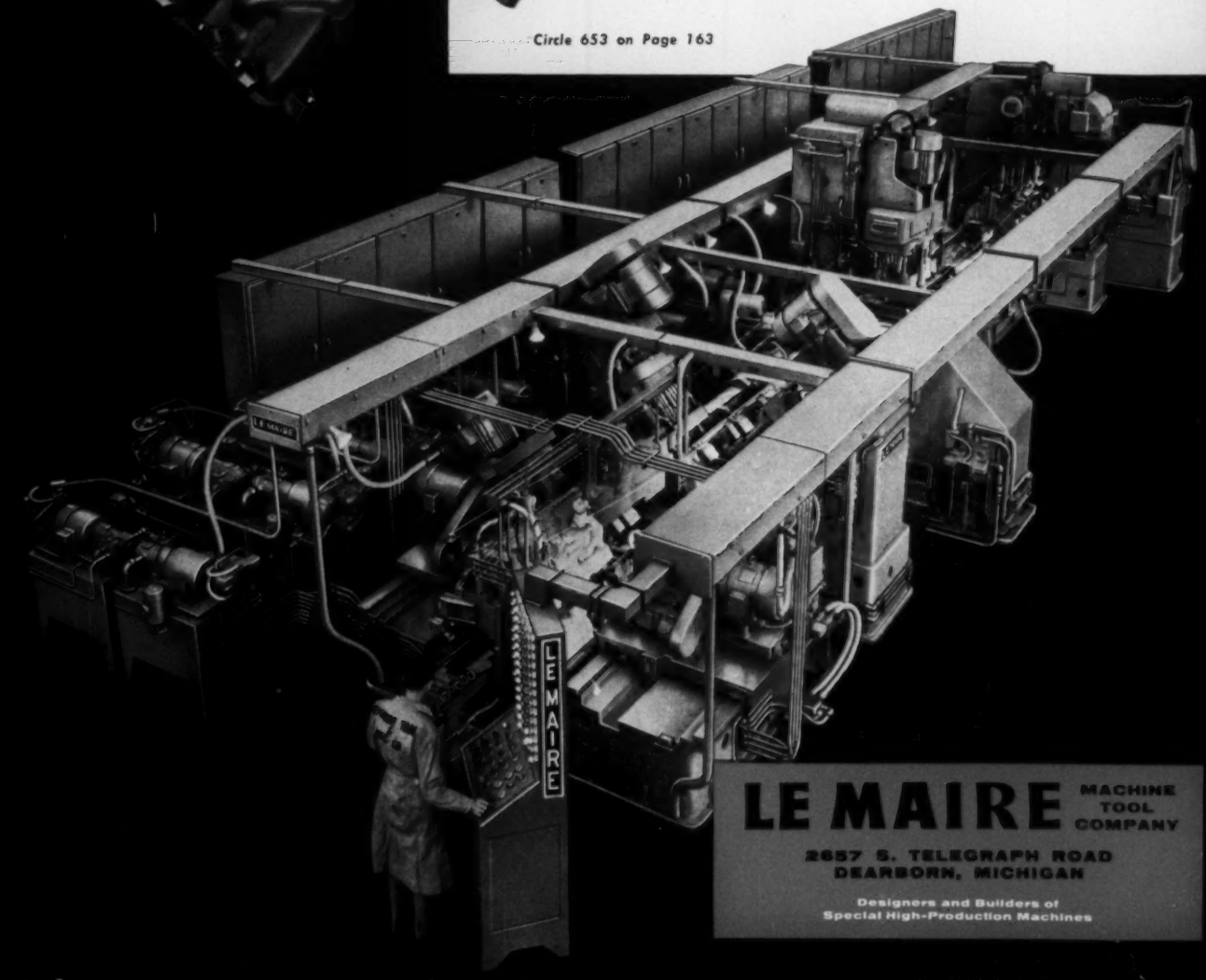

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